Has food lost its attraction in anorexia nervosa?

Neimeijer, Renate Antonia Maria

HAS FOOD LOST ITS ATTRACTION IN ANOREXIA NERVOSA ?

A COGNITIVE APPROACH

RENATE NEIMEIJER

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A cognitive approach

Renate Neimeijer

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Renate Antonia Maria Neimeijer

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Promotor

Prof. dr. P.J. de Jong

Copromotor

Dr. A. Roefs

Beoordelingscommissie

Prof. dr. M.M. Lorist

Prof. dr. C. Braet

Prof. dr. A. Jansen

Paranimfen

Klaske Glashouwer

Rozemarijn Vos

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Chapter I

General introduction

ANOREXIA NERVOSA

Anorexia nervosa (AN) is characterized by a refusal to maintain body weight at or above a minimally healthy weight for age and height, and an intense fear of gaining weight or becoming overweight, even though underweight. Furthermore, there is a disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight (American Psychiatric Association, 1994). AN has severe physical consequences and a devastating influence on the quality of life of patients and their significant others. In addition, it is the mental disorder associated with the highest mortality risk, approximately 5% of patients die of the consequences of the disorder (Sullivan, 1995). The average point prevalence is 0.3 % (Hoek, 2006) and the life time prevalence is 0.9 % among women (Hudson, Hiripi, Pope, & Kessler, 2007).

According to the transdiagnostic model (Fairburn, Cooper, & Shafran, 2003), all eating disorders share a core psychopathology: an over-evaluation of eating, shape and weight, and of the ability to control them. Whereas most people evaluate themselves on the basis of their perceived performance in a variety of domains of life (e.g., relationships, school, work), people with eating disorders largely base their self-evaluation on their eating behaviour, and their shape and weight (Fairburn et al., 2003).

Strict dieting to influence body shape and weight is a 'logical' consequence of this negative body-image. However, most people who start dieting are not capable of maintaining their restrictive eating pattern for a longer period. As soon as they quit dieting, many dieters even gain more weight than they initially lost (Mann et al., 2007). People with a chronic intention to lose weight are called restrained eaters (Herman & Polivy, 1980). Although restrained eaters are very motivated to control their weight by dieting, they are often unsuccessful in these attempts, and their eating behaviour is characterized by alternating periods of restraint and bouts of overeating (Gorman & Allison, 1995). AN patients belong to the small minority of dieters who are able to keep their diet for a longer period of time.

The central question of this thesis is how to explain AN patients' ability to maintain their diet, in contrast with the majority of dieters (i.e., restrained eaters). Therefore, two cognitive motivational mechanisms were studied in both successful (AN patients) and unsuccessful dieters (restrained eaters), to understand the ability of AN patients to successfully regulate their food intake: attentional bias (AB) for high caloric foods and automatic approach tendencies towards food.

ATTENTIONAL BIAS

One explanation for the contrast between successful (AN patients) and unsuccessful dieters (restrained eaters) could be that AN patients are relatively effective in ignoring the automatic seductive properties of food items, and/or are less sensitive to the bottom-up attention capturing effects of food stimuli. The visual world is bursting with information, and stimuli continuously compete for a perceiver's attention: Stimuli that win often, reach awareness, whereas those that lose frequently go unnoticed (Most, Smith, Cooter, Levy, & Zald, 2007).

According to the incentive sensitization theory (Robinson & Berridge, 1993), applied to excessive food intake (Franken, 2003), incentive salience qualities are attributed to food and food-related stimuli (such as pictures or smell of food). The perception of food stimuli leads, due to classical conditioning, to dopamine release. As a consequence of this conditioning process, food-related stimuli grab more attention, elicit craving, and lower the threshold for food intake. It has further been argued that a reciprocal relationship exists between attention bias and craving, and that it is a self-reinforcing cycle: Biased attention for food cues is thought to elicit food cravings, but craving food can also lead to an AB. To illustrate, an induced chocolate craving led to an AB (increased distraction by chocolate pictures) in healthy-weight participants (e.g., Smeets, Roefs, & Jansen, 2009), whereas on the other hand, an induced AB was linked to more craving (Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). Consistent with the idea that an AB can contribute to lowering the threshold for actual food intake, a study using an eye tracker showed that an AB for food in hungry participants was associated with higher caloric intake during a bogus taste test (Nijs, Muris, Euser, & Franken, 2010).

If AN patients are not sensitive to the appetizing characteristics of food, this might help them to avoid entering the attention-craving-eating cycle. In contrast, restrained eaters might, analogous to addiction, have heightened attention for food cues, thereby enhancing craving for food. This might make them more sensitive for food temptations and for overeating. However, studies on AB for food in restrained eaters show a very inconsistent pattern of results, with evidence for enhanced AB, reduced AB, or an AB that is not different from unrestrained participants (see for a review: Werthmann, Jansen, & Roefs, 2015).

The mixed results might partly be due to methodological differences across studies. Furthermore, most studies in the context of eating and AB focused on attention that is directed towards or away from food, or in other words, attention in the spatial domain. Paradigms developed to test this orienting of attention only allow examining 'snapshots' of attention. Attention is also distributed in the temporal domain. Salient information might not only cause a shift to the spatial location, but also induce a temporal 'blindness' for other information that is presented shorty before or after the salient cue. The visual world is highly dynamic, so temporal AB seems relevant and differences might also be expressed in this domain. To illustrate, it might not only be that a picture of your favourite food in a magazine attracts your attention, but it might also be that due to the identification of this picture, other information (that appears shortly before or after the food picture) is missed. Consequently, the picture remains longer in working memory, which in turn may give rise to craving and an increase in actual food intake. It would therefore be of interest to also study the temporal dimension of attention in the context of successful and unsuccessful dieting.

A task that is often used to measure the temporal dynamics of attention is the Rapid Serial Visual Presentation task (RSVP: Raymond, Shapiro, & Arnell, 1992). In the RSVP task stimuli are presented sequentially without interstimulus interval on a computer screen. In every stream of pictures, one or two targets appear, which have to be identified *after* each stream. The lag (time) between the two targets can be manipulated. See Figure 1 for an overview of the task.

Basic research in the temporal dimension of visual attention has consistently shown that the ability

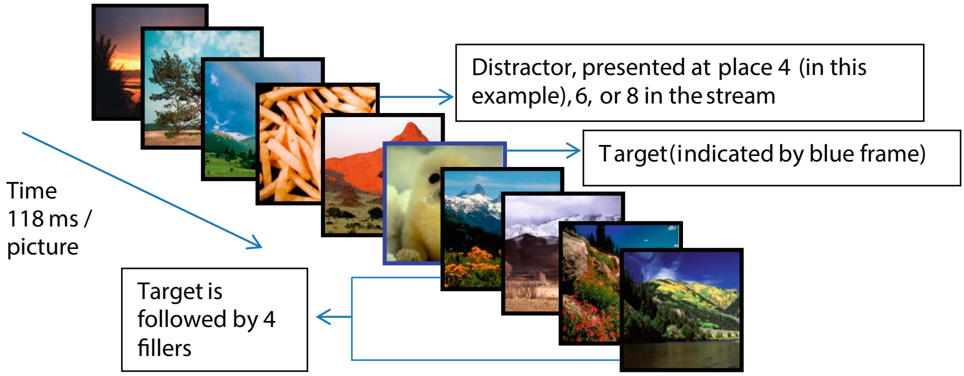

Figure 1. *Example of a single target trial (third type of RSVP trials), lag 2*

to identify a particular target is deteriorated when another target is presented in close temporal proximity. The deficit in the identification of the second target (T2) has been called the attentional blink, referring to the apparent refractory period following the presentation of the preceding target (T1). When the interval (lag) between the targets increases, T2 performance is no longer hampered. Temporal attentional bias can be expressed in at least four different ways within the context of a RSVP task: (1) Attentional blink can be diminished (magnitude of attentional blink is reduced) when T2 is a salient cue (e.g., food stimulus), and therefore T2 will be identified despite the preceding T1 (e.g., Shapiro, Caldwell, & Sorensen, 1997). (2) The appearance of a salient T2 (e.g., food) may interfere with the correct identification of a preceding T1 ('backward blink', Potter, Staub, & O'Connor, 2002). (3) Attentional blink can be enhanced when T1 is a salient cue and, therefore, the attentional blink will last longer than the usual attentional blink (Koster, Raedt, Verschuere, Tibboel, & De Jong, 2009). (4) An attentional blink can be elicited when a salient task-irrelevant distractor (e.g., food) is presented shortly before the actual target. The distractor can be ignored but may nevertheless induce an attentional blink (e.g., Most et al., 2007).

Using a RSVP, the study presented in Chapter 2, examined whether temporal AB is heightened in restrained eaters. To test whether this group of restrained eaters is sensitive to attentional capture by food cues, this group is compared with unrestrained eaters. It is hypothesized that in contrast with restrained eaters, AN patients are relatively insensitive to the attentional capture by food stimuli, and are therefore not distracted by the presentation of visual food cues. In chapter 3, performance on a RSVP of AN patients is compared with a comparison group without an eating disorder to test this hypothesis.

AUTOMATIC APPROACH TENDENCIES

Once food is in the centre of attention, the information is processed and various behavioural tendencies are activated. Dual process models state that there are two systems of information processing that influence evaluations and behaviour: an impulsive system and a reflective system. The impulsive system operates fast and without conscious awareness, evaluates stimuli in terms of their motivational significance and is not accessible to introspection. The reflective system on the other hand, involves more slow, controlled and deliberate processes and impulse regulation (e.g., Deutsch & Strack, 2006). It is proposed that these processes are largely independent and both can influence behaviour. Deliberate processes are assumed to be predictive in situations where sufficient cognitive resources are available, while automatic processes guide impulsive behaviour and play a role in situations where less cognitive resources are available, as for instance under stress (e.g., Gawronski & Bodenhausen, 2006). Motivational processes should therefore not only be measured by means of subjective self-reports, but also by using indirect measurement procedures that do not rely on introspection, as is done in the current thesis. However, it should be mentioned that there is some debate about what defines automaticity and to what extent implicit measures, as obtained by indirect measurement procedures, can really be considered implicit (e.g., De Houwer, 2006; Moors & De Houwer, 2006).

One example of a more automatic process is the tendency to approach food, and this process is the second cognitive motivational mechanism that is studied in this thesis to understand the ability of AN patients to successfully regulate their food intake. Although approach tendencies towards food might be generally helpful to survive, such an automatic inclination to approach food might also interfere with a diet goal (Kakoschke, Kemps, & Tiggemann, 2015). One might argue that automatic approach tendencies towards food are closely related to positive affective associations with food (e.g., Roefs et al., 2011; Tibboel et al., 2011).

Different paradigms are used to measure automatic affective associations with high caloric food, as for instance the implicit association task (IAT; Greenwald, McGhee, & Schwartz, 1998) and the affective priming paradigm (APP; Hermans, De Houwer, & Eelen, 1994). One study indeed showed that restrained eaters have positive associations with high caloric food on an implicit measure (Hoefling & Strack, 2008), whereas AN patients do not have more positive associations with palatable than with unpalatable food, whereas the healthy-weight control group did (Roefs et al., 2005). However, there are also studies showing the opposite pattern (negative associations with high caloric food in restrained eaters) (Maison, Greenwald, & Bruin, 2001; Vartanian, Polivy, & Herman, 2004), and there is a study that observed no significant differences between restrained and unrestrained eaters (Roefs, Herman, MacLeod, Smulders, & Jansen, 2005).

So, previous research using the IAT and APP showed no straightforward relationship between food-related affective associations and dietary restrained and AN. One explanation could be that this was due to the types of tasks that have been used to assess affective associations. For example, the IAT and APP do not rely on actual approach-avoidance responses and may therefore not optimally model people's actual behavioural tendencies. Germane to this, it has been argued that automatic affective associations might diverge from people's behavioural tendencies (e.g., Veenstra de Jong, 2010), which may be automatically activated upon confrontation with particular stimuli, independently of evaluative associations (Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010).

Consistent with the view that automatic approach tendencies might play a crucial role in the ability to regulate food intake, it was found that AN patients showed lower automatic approach tendencies towards high caloric food than participants without an eating disorder (Paslakis et al., 2016; Veenstra & de Jong, 2011). In contrast, restrained eaters and obese people showed enhanced approach tendencies towards food as compared to unrestrained eaters and healthy-weight controls (e.g., Veenstra & de Jong, 2011; Kemps & Tiggemann, 2015).

A bias to approach food might play a role in various contexts. First of all, it may affect eating-relevant behaviour during meals, where one has to choose what and how much to eat. Strong approach tendencies may then affect both the selection of food (e.g., approach tendencies may be stronger for high than for low caloric food items) and the amount of food-intake. To model this type of situations, it is important that there is a direct contingency between the presence of tempting food and the required behavioural response. Therefore, we selected the Stimulus Response Compatibility task (SRC- De Houwer, Crombez, Baeyens, & Hermans, 2001) as a measure to assess participants' food approach (or avoidance). In this task, participants are instructed to move a manikin figure on the computer monitor towards or away from a category of pictures (e.g., food pictures). See figure 2 for an example trial of an approach avoidance task (e.g., de SRC).

In one part of the task, participants are instructed to approach food pictures, and avoid non-food pictures, whereas in another part of the task this instruction is reversed. The difference

Figure 2. *Example of an approach avoidance task- trial*

in performance between the two parts of the task is taken to reflect the automatic tendency to approach or avoid food. In the SRC task, food is task-relevant (because one has to approach or avoid depending on whether the picture contains food or not), just as food is task-relevant in the context of a meal. Therefore, relatively strong approach tendencies as indexed by the SRC might potentially be predictive for situations like meal times. Earlier research with a task-relevant approach-avoidance paradigm has found dieters showed, in line with their diet goal, reduced approach tendencies towards high caloric food words compared to non-dieters (Fishbach & Shah, 2006). So far, no study has used the SRC in AN patients.

Automatic approach tendencies towards food might, however, also be elicited in situations where food is irrelevant for one's current task. For example, when passing a chocolate shop while shopping for new clothes, one might be seduced by the sight of chocolate. Outside a regular meal time, one is less actively thinking of the diet goal and consequently self-control might be reduced. So especially when food is irrelevant for the current task and someone is doing something else, approach tendencies might be elicited when food is (unexpectedly) seen or smelled. This might consequently be predictive of (over) eating in restrained eaters and thereby interfering with their diet goal.

To measure approach tendencies towards food when food is task-irrelevant, another version of the approach avoidance task can be used: the Affective Simon Task (AST). In the AST- manikin version, response requirements depend on stimulus features that are unrelated to the food/non-food content of the pictures, such as the orientation of the stimulus (top versus side view of the object on the picture; e.g., Veenstra & de Jong, 2010). So, for selecting the adequate response (approach-avoidance), participants do not need to categorize a stimulus as food or non-food. For example, a participant could be instructed to approach top view pictures and to avoid side view pictures, while the content (food/ non-food) can be ignored. Although food versus non-food is task-irrelevant in the AST, the effect of the task-irrelevant food vs. non-food content of the pictures on response latencies can be analysed, and is in fact used to index automatic, spontaneously elicited, responses to approach or avoid food. See figure 3 for example pictures of high caloric, low caloric, and neutral pictures in top view and side view.

The critical difference between successful (e.g., AN patients) and unsuccessful dieters (restrained eaters) might be to what extent automatic approach tendencies towards food are shown outside a meal situation. Especially outside meal situations, these approach tendencies might be problematic for keeping food intake consistent with an explicit diet goal, because restrained eaters are less aware of their diet goal and probably more vulnerable for automatic approach tendencies. AN patients, in contrast, might be less sensitive for the tempting properties of food in situations outside of meal times. In other words, they may not be as vulnerable to temptation by the sight or smell of food when they are doing something else. Consistent with this view, previous research using an AST found that indeed restrained eaters and obese people show enhanced approach tendencies towards food (e.g., Veenstra & de Jong, 2011; Kemps & Tiggemann, 2015), whereas AN patients

Figure 3*. Example pictures of high caloric, low caloric, and neutral pictures in side view and top view.*

showed lowered approach tendencies than participants without eating disorder problems (Paslakis et al., 2016; Veenstra & de Jong, 2011). No study so far compared performance in both paradigms directly, while they potentially model different situations. In this thesis, measures of the automatic approach towards food when food is task-relevant as well when task-irrelevant are directly compared restrained eaters and in AN patients.

Chapter 4 describes a study on automatic approach tendencies towards food in restrained eating, to test if restrained eaters show heightened approach tendencies compared to unrestrained controls. As a second aim, this study tested the influence of mood on approach bias and eating behaviour. The reason that mood was taken into account is that implicit measures of associations may not be stable, but instead are context dependent and vary as a function of for instance mood. It is hypothesized that both positive and negative mood might be involved in craving and intake (Baker, Morse, & Sherman, 1986). Negative-affect craving is triggered by a negative emotional response or aversive events, whereas the positive-affect craving system is activated by positive emotional states or cues paired with eating and its pleasurable or positively reinforcing effects. When activated, both the positive and the negative affect system could induce craving experiences, approach behaviour, affect, and corresponding physiological reactions.

To test if AN patients show less approach or even avoidance tendencies toward high-caloric food both when food is task-relevant and when food is task-irrelevant, a large group of AN patients is compared with a comparison group. This study is described in Chapter 5. Furthermore, to determine whether reduced automatic approach tendencies are crucial in the maintenance of AN, a longitudinal study was conducted, as described in Chapter 6. It was hypothesised that a reduction in eating disorder symptoms between baseline and follow up is associated with an increase of approach tendencies toward food, and that lower automatic approach tendencies at baseline are predictive for treatment outcome after one year follow up.

OUTLINE THESIS

To summarize, the global aim of the studies presented in this thesis was to improve our understanding of AN patients' striking ability to maintain their diet, in contrast with restrained eaters. Although individuals in this latter group are very motivated to control their weight by dieting, they are often unsuccessful in these attempts (Herman & Polivy, 1980). Together, all studies potentially contribute to the understanding of which cognitive processes are involved in successful and unsuccessful dieting. Both AB and automatic approach tendencies, together with explicit measures of craving, eating disorder symptoms and weight are studied to gain this insight. Chapters 2 and 3 focus on the possible role of temporal attentional bias in the (dys)regulation of food intake in restrained eaters (chapter 2) and anorexia nervosa patients (chapter 3). It is hypothesized that restrained eaters show enhanced distraction by food cues compared to unrestrained eaters and that, in contrast, AN patients are less sensitive to attentional capture compared to the comparison group without an eating disorder. Chapters 4, 5, and 6 describe studies about automatic approach tendencies towards food in AN and restrained eaters, both when food is task-relevant and when food is task-irrelevant. It is hypothesized that restrained eaters show more approach tendencies towards (high) caloric food, whereas AN patients show less approach tendencies or even avoidance tendencies. Furthermore, it is hypothesized that for AN patients, automatic approach tendencies towards food will increase after treatment, and that (low) approach tendencies at baseline are predictive for eating disorder symptoms at one year follow up.

Chapter 2

Temporal Attention for Visual Food Stimuli in Restrained Eaters

This chapter is based on: Neimeijer, R. A. M., de Jong, P. J., & Roefs, A. (2013). Temporal attention for visual food stimuli in restrained eaters. Appetite, 64, 5-11.

ABSTRACT

Although restrained eaters try to limit their food intake, they often fail and indulge in exactly those foods that they want to avoid. A possible explanation is a temporal attentional bias for food cues. It could be that for these people food stimuli are processed relatively efficiently and require less attentional resources to enter awareness. Once a food stimulus has captured attention, it may be preferentially processed and granted prioritized access to limited cognitive resources. This might help explain why restrained eaters often fail in their attempts to restrict their food intake. A Rapid Serial Visual Presentation task consisting of dual and single target trials with food and neutral pictures as targets and/or distractors was administered to restrained (n = 40) and unrestrained (n = 40) eaters to study temporal attentional bias. Results indicated that (1) food cues did not diminish the attentional blink in restrained eaters when presented as second target; (2) specifically restrained eaters showed an interference effect of identifying food targets on the identification of preceding neutral targets; (3) for both restrained and unrestrained eaters, food cues enhanced the attentional blink (4) specifically in restrained eaters, food distractors elicited an attention blink in the single target trials. In restrained eaters, food cues get prioritized access to limited cognitive resources, even if this processing priority interferes with their current goals. This temporal attentional bias for food stimuli might help explain why restrained eaters typically have difficulties maintaining their diet rules.

INTRODUCTION

The prevalence of obesity has tripled in many countries of the WHO European Region since the 1980s, and the numbers of those affected have risen at an alarming rate. Because obesity is the result of a chronic imbalance between energy intake and energy expenditure, dieting is a logical strategy to lose weight. However, not many dieters are able to maintain their initial weight loss over a longer period of time (Elfhag & Rössner, 2010; Jeffery et al., 2000). As soon as they quit dieting, many dieters even gain more weight than they initially lost (Mann et al., 2007). People with a chronic intention to lose weight are called restrained eaters (Herman & Polivy, 1980). Although restrained eaters are very motivated to control their weight by dieting, they are often unsuccessful in these attempts, and their eating behaviour is characterized by alternating periods of restraint and bouts of overeating (Gorman & Allison, 1995).

Biased processing of food cues might be one of the mechanisms involved in restrained people's difficulty to control their food intake. Germane to this, it has been proposed that there is a reciprocal relationship between selective attention for food cues (attentional bias) and craving (Franken, 2003). Following this view, attentional bias would lead to craving for food, whereas in its turn, enhanced craving would again strengthen the attentional bias for food. Accordingly, people may end up in a self-reinforcing cycle, which will logically undermine their attempts to restrict their food intake.

However, previous studies, using various paradigms to measure attentional bias, largely failed to find evidence for the hypothesized heightened vigilance toward high caloric food items in restrained eaters. Originally, the Stroop paradigm was often used. Previous studies using this paradigm in the context of restrained eaters found mixed evidence for color naming interference effects for food words compared to neutral words. (see for a review: Dobson & Dozois, 2004). However, the use of Stroop tasks in research for attentional bias is debatable, because the color-naming interference effects can be the result of both heightened attention for food-related material as well as avoidance of food-related material (de Ruiter & Brosschot, 1994). A recent study used a modified version of the Stroop task to distinguish between orientation and disengagement and found that restrained eaters had no orientation bias but showed a slowed disengagement for food cues as well as for ego threat cues (Wilson & Wallis, 2013). Furthermore, studies used also other more straightforward indices of (spatial) attention such as the visual probe task. However, studies using visual probe tasks failed to find evidence for heightened attention towards (or away from) food words (Boon, Vogelzang, & Jansen, 2000) or food pictures (Ahern, Field, Yokum, Bohon, & Stice, 2010) in restrained eaters. Likewise, a study using an exogenous cuing task with food pictures also failed to find an attentional bias for food stimuli in restrained eaters (Veenstra, de Jong, Koster, & Roefs, 2010). Finally, a study employing a visual search task did show that restrained eaters were faster in detecting a food word in a neutral matrix. However, restrained eaters were also faster in detecting neutral words in a food matrix (Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010).

In sum, previous research provided no straightforward support for the hypothesized role of attentional bias in restrained eaters' failure to regulate their caloric intake. However, all of these earlier studies on attentional bias in restrained eating exclusively focused on spatial selective attention. Importantly, attention is not only distributed over space, but also over time. The privileged processing of food cues may be especially prominent in the temporal dimension. For example, it could be that for restrained eaters food stimuli are processed relatively efficiently and require less attentional resources (lower threshold) to enter people's awareness. Once a food stimulus has captured attention, it may be preferentially processed and granted prioritized access to limited cognitive resources (cf. Koster et al., 2009). Such privileged access may not only prevent new information from entering working memory, but may also provide the opportunity for more elaborate processing of the food stimulus. This is in line with the 'elaborated intrusion theory of desire', that states that intrusive thoughts about appetitive targets are triggered automatically by external cues. When intrusions elicit significant pleasure or relief, this will usually promote cognitive elaboration. Elaboration competes with concurrent cognitive tasks through retrieval of target related information and its retention in working memory (Kavanagh, Andrade, & May, 2005). External cues of 'forbidden food' might have this same effect for restrained eaters. Finally, food cues might not only receive processing priority when people are actively looking for food cues (top-down controlled), but may also more automatically attract attention (bottom-up), even at the expense of current task performance (Piech, Pastorino, & Zald, 2009). Thus far, the potential role of the *temporal* dimension of attentional bias in restrained eating has been largely ignored. Further insight into the temporal dynamics of attention for food stimuli may help explain why restrained eaters may experience difficulty in regulating their food intake. Therefore, the aim of the current study is to test whether temporal attentional bias might indeed be involved in restrained eating.

A task often used to measure temporal attention is the Rapid Serial Visual Presentation task (RSVP), in which stimuli are presented sequentially without interstimulus interval (e.g., 118 ms/stimulus) on a computer screen. In every stream of pictures one or two targets appear, that have to be identified *after* each stream. The lag (time) between the two targets can be manipulated. Basic research in the temporal dimension of visual attention has consistently shown that the ability to identify a particular target is deteriorated when another target is presented in close temporal proximity (< 500 ms). The deficit in the identification of the second target (T2) has been called the attentional blink, referring to the apparent refractory period following the presentation of the preceding target (T1). When the interval (lag) between the targets increases (>500 ms), T2 performance is no longer hampered.

Temporal attentional bias can be expressed in at least four different ways within the context of a RSVP task: (1) Attentional blink can be diminished (magnitude of attentional blink is reduced) when T2 is a salient cue (e.g., food stimulus), and therefore T2 will be identified despite the preceding T1. (2) The appearance of a salient T2 (e.g., food) may interfere with the correct identification of a preceding T1 (backward interference). (3) Attentional blink can be enhanced when T1 is a salient cue and, therefore, the attentional blink will last longer than the usual attentional blink (500 ms). (4) An attentional blink can be elicited when a salient task-irrelevant distractor (e.g., food) is presented

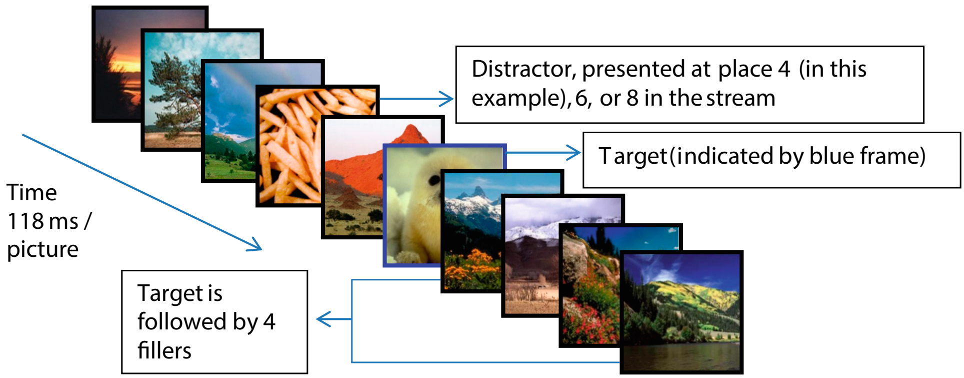

Figure 1. *Example of a single target trial (third type of RSVP trials), lag 2*

shortly before the actual target. The distractor can be ignored but may nevertheless induce an attentional blink. In the following each of these four types of temporal attentional bias will be addressed in more detail.

First, it has been shown that the attentional blink is diminished (i.e., higher identification rates of T2) when the T2 is of high personal relevance (e.g., the participant's name: Shapiro et al., 1997). To explain this reduced attentional blink effect, it has been argued that highly salient stimuli are processed relatively efficiently thereby lowering the threshold for accurate identification, even when only little attentional resources are available. To the extent that food cues are highly salient for participants, also food stimuli may diminish the attentional blink, thereby heightening the probability that food items will enter people's awareness. The present study will examine whether indeed food stimuli, as compared to neutral stimuli, are more easily identified (diminish the attentional blink) when presented as T2, and whether this might be especially the case for restrained eaters.

Second, there is evidence that the appearance of a salient T2 may interfere with the correct identification of a preceding T1 (i.e., lower identification rates of T1), this backward interference effect has also been called a 'backward blink' (Potter et al., 2002). For example, when a T2 is presented very shortly after a T1, T2 has even been found to be correctly identified more often than the preceding T1 (Potter et al., 2002). There might as well be an interference effect of food T2 targets on T1 identification for restrained eaters.

Illustrating the third type of temporal attentional bias, that attentional blink can be enhanced by a salient T1, (i.e., lower identification rates of T2), it has been shown that negative self-descriptors as T1 resulted in an enhanced attentional blink in dysphoric participants (Koster et al., 2009). A similar T1-enhanced attentional blink effect has been shown when angry faces were presented as T1 (de Jong, Koster, van Wees, & Martens, 2010). Thus, it appears that self-relevant salient stimuli elicit more elaborate processing, which is reflected in the associated temporal attention costs. In a similar vein, it can be hypothesized that specifically for restrained eaters, food stimuli might also receive more elaborate processing thereby enhancing the attentional blink.

The fourth type of temporal attentional bias refers to the phenomenon that also task-irrelevant distracters may elicit an attentional blink (i.e., lower identification rates of a target presented after the distractor). In the typical attentional blink tasks people have to identify two targets, which are presented in a stream. Hence, the content of the stimuli (e.g., food) is typically a task-relevant stimulus feature. If food items are used as T1 or T2, this implies that people are instructed to actively search for food stimuli. However, it is also important to verify whether food items may also attract attention when they are task-irrelevant. In other words, also when people are not intentionally searching for food stimuli, such stimuli may nevertheless elicit an attentional blink. To assess such processing priority of food stimuli, food cues may be used as task-irrelevant distractors in a single target RSVP. Germane to this, it has been shown that positive arousing pictures (nudes of the preferred sex) as a task-irrelevant distractor stimulus, can elicit an attentional blink when presented close to the target slide (Most et al., 2007). Interestingly, this preferential processing of task-irrelevant distractors (the nude stimuli) was evident despite a strong incentive to ignore the task-irrelevant distractor. This is therefore assumed to reflect more automatic (non-intentional) attentional processes. In a similar vein, it could be that food items may attract attention even if these items are irrelevant for people's current goals. Therefore, the present study also included a third type of RSVP trials, that were designed to test whether indeed especially in high restrained individuals, food distractors would elicit an attentional blink even in a context that motivates to ignore these stimuli (i.e., to optimize task performance).

Present study

The present experiment covers the four types of temporal attentional bias in three types of RSVP trials that were discussed above and was designed to investigate the temporal characteristics of attentional bias in the context of restrained eating. In short, the study tested the following hypotheses involving restrained eaters: (i) The attentional blink is diminished when T2 is a food stimulus; (ii) food T2s interfere with correct identification of a preceding neutral target (backward interference); (iii) the attentional blink is enhanced with food T1s, and (iv) task-irrelevant food cues elicit an attentional blink. Therefore, we subjected a group of participants with varying food-restrain tendencies to these three variants of RSVP tasks.

METHOD

Participants

Participants were first year female psychology students of the University of Groningen (n = 80). All participants gave their written informed consent to take part. By means of a median split of the Restraint Scale (RS: Herman & Polivy, 1980), participants were divided into a group of high and a group of low restrained eaters. Participants scoring higher than 10 (n = 40) were classified as restrained eaters (BMI: M = 23.45; SD = 2.62; range = 18.83-30.09, age: M = 20.1; SD = 1.88; range 18-24). Participants scoring 9 or lower on the RS (n = 40) were classified as low restrained eaters (BMI: M = 21.18, SD = 2.18, range = 16.63-27.28, age: M = 22.3; SD = 5.21; range 18-48). High RS participants had a higher BMI than low RS participants, $t(78) = 4.21$, $p < .01$.

Materials

RSVP

The task was performed on a Windows XP computer with a 22-inch monitor (resolution set to 1280 by 1024 pixels), and was programmed in E-prime 2.0 (Schneider, Eschman, & Zuccolotto, 2002). Experimental trials consisted of a Rapid Serial Visual Presentation (RSVP) stream, with 1 or 2 critical stimuli (T1 and T2) in each stream. In a trial were, dependent on the place of the first target and the lag, 10-19 pictures shown for 118 ms each without interstimulus interval. The last target was always followed by a fixed number of four fillers, to ensure that any differences in results across types of trials could not be attributed to a variable time the final target had to be kept in working memory. The order of the trials, as well as which pictures were paired with which lag were individually randomized.

First type of RSVP trials. To test hypothesis 1, that attentional blink is diminished by a food T2 and hypothesis 2, that a food T2 have an interference effect on participants' ability to identify T1, a dual target task was designed. In this task, T1 (always neutral) was randomly presented on one of three possible positions in the stream (4, 6, 8). T2 (food/neutral) was randomly presented at lag 2, 3, 4 or 7 following T1. Each combination of T1 position and T2 position was presented equally often. In the present set up there were 3 (T1 position: 4, 6, 8) × 4 (lag: 2, 3, 4, 7) × 2 (T2: food, neutral) = 24 different types of trials, each presented six times. For hypothesis 1, percentage correct T2s were calculated as a function of T2 type. Only trials with correct T1 identification were included. For hypothesis 2, percentage correct T1s as a function of T2 type were calculated. To retain sufficient trials, all trials were included, regardless of (accurate) T2 identification.

Second type of RSVP trials. To test hypothesis 3, that food T1's can enhance the attentional blink, another dual target task was designed. This type of RSVP trials are similar to the first type of RSVP trials, with the only difference being that T1 is either food or neutral and T2 always neutral. This resulted in a total of 24 different types of trials from which 12 overlapped with the first type of RSVP trials (T1 neutral and T2 neutral), each presented six times. Percentage correct T2's as a function of T1 were calculated. Only trials with correct T1 identification were included.

Third type of RSVP trials. To test hypothesis 4, that food distractors can elicit an attentional blink even when task-irrelevant, a single target task was designed. To test the specificity of this food-distraction effect, we also included threatening stimuli as distractors in addition to the neutral (control) and food-related distractors. The distractor was randomly presented on one of three possible positions in the stream (4, 6, 8). The target was randomly presented at lag 2 or 8 following the distractor. In the present setup there were 3 (type of distractor: food, threat, neutral) × 3 (T1 position: 4, 6, 8) × 2 (lag: 2, 8) = 18 different types of trials, each presented six times. Percentage correct T's as a function of distractor were calculated.

Stimuli

Stimuli, measuring 550 × 550 pixels, were photographs: 46 high caloric food stimuli, 39 threatening stimuli, 57 neutral pictures and 75 fillers (landscapes). The neutral and threat pictures were taken from the International Affective Picture System (IAPS). Food pictures were purchased on Istockphoto. Neutral pictures consisted of people, animals and everyday objects like money, a book, and shoes (see Appendix 1). Food pictures consisted of a wide range of high caloric palatable food pictures, like fries, a burger, cake, chocolate, and a pizza. Threatening pictures were of people or animals and consisted of medical trauma, distress, and violence (see Appendix 1). Target pictures had a 10-pixel blue frame, while all other stimuli had a 10 pixel black frame. During the entire series of RSVP trials, each single picture was presented for approximately five times.

Visual analogue scales for food liking, craving, and consumption

Participants assessed the liking of food items of the RSVP by answering the question: "How much do you like this product" using a visual analogue scale (VAS) from 0 (*not at all*) to 100 (*very much*). Craving was measured using the question: "How much do you crave for this product at this moment?", which was rated on a VAS ranging from 0 (*not at all*) to 100 (*very much*). Furthermore, participants were asked to assess the frequency with which they ate the particular food using the question "How frequently do you eat this product", which was answered on a VAS ranging from 0 (*not at all*) to 100 (*very much*).

Hunger scale

The Hunger Scale (HS: Grand, 1968) consists of hunger items (time since last eating, subjective hunger, estimate of the amount of favourite food able to eat, estimate of time until next expected meal) and was administered to control for the influence of hunger. Scores on the four items were combined to form a composite hunger index. High scores refer to hunger or deprivation from food.

Restraint scale

The Restraint Scale (Herman & Polivy, 1980) consists of 10 items and was used to measure the participant's intention to diet. Values can range from 0 to 35, with higher scores reflecting a stronger intention to restrain. Test–retest reliability is high (r = 0.95) and internal consistency has been estimated at α = .82 (Allison, Kalinsky, & Gorman, 1992). It is assumed that the Restraint Scale identifies unsuccessful dieters who have a higher tendency toward overeating (van Strien, Herman, Engels, Larsen, & van Leeuwe, 2007).

Procedure

After signing informed consent, the RSVP was administered. A participant started with a 20-trials practice session. Hereafter, a total number of 324 trials were presented in three similar blocks of 108 trials, with a 30 s break following each block to reduce the influence of fatigue and problems with participants' concentration. Trials of all three described RSVP types were presented intermixed, in a unique random order for each participant. After each trial, participants were asked how many pictures they had seen with a blue frame (targets) and what the content of these pictures was. They gave their answer verbally to the experimenter, who, in turn, indicated on a response box whether the answer was correct and specific. If the response was not sufficiently specific, the experimenter asked for clarification. After the RSVP the VAS, RS, and HS were filled out. Finally, height and weight were measured. During the task participants were not allowed to eat or drink.

RESULTS

Group characteristics

Restrained and unrestrained eaters did not differ in their self-reported frequency of high-fat food consumption, $t(78) = 1.45$, $p = .15$. They also did not differ with respect to their current motivational state of hunger, $t(78) = 0.99$, $p = .32$, which rules out the influence of hunger as an explanation of potential group differences. Restrained and unrestrained eaters did not differ in their self-reported craving for high-fat food, $t(78) = 1.22$, $p = .23$ or liking of high-fat food, $t(78) = 0.53$, $p = .56$.

Do food T2 stimuli diminish the attentional blink specifically for restrained eaters? (first type of RSVP trials)

Mean percentages correctly identified T2s are presented in Table 1 as a function of T2 type, lag and group. The number of correctly identified T2's were subjected to a 4 (lag: 2, 3, 4, 7) × 2 (T2 type: food, neutral) × 2 (group: restrained, unrestrained) mixed ANOVA. There was a significant main effect of lag, $F(3, 234) = 387.11$, $p < .01$, $\eta^2_p = .83$, indicating that participants showed an attentional blink when the time-lag between T1 and T2 was small (lags 2 and 3), whereas the blink almost disappeared when the time-lag was large (lag 7). This is consistent with earlier research in the temporal dimension of visual attention. Contrasts indicated that every lag differed significantly from the previous lag (lag 2 vs. lag 3: $F(1, 78) = 490.11$, $p < .01$, $\eta^2_p = .86$, lag 3 vs. 4, $F(1, 78) = 76$, $p < .01$, $\eta^2_p = .49$, lag 4 vs. lag 7, $F(1, 78)$ 18.39, $p < .01$, $\eta^2_p = .19$. Thus, the longer the time-interval between T1 and T2, the higher the frequency of correct T2 identifications. This effect was similar for food and neutral T2s and independent of group, as was evidenced by the absence of a lag × T2 type interaction, $F(3, 234) = 1.09$, $p = .36$ and a lag × group interaction, $F(3, 234) = 1.63$, $p = .18$ respectively. In contrast to hypothesis 1, neutral T2's were generally more often correctly identified than food T2s as was evidenced by a main effect of T2 type, $F(1, 78) = 10.06$, $p < .01$, $\eta^2_p = .11$. There was no expected significant T2 type × group interaction effect, $F(1, 78) = .17$, $p = .68$, neither a T2 type × group × lag interaction, $F(3, 234) = .77$, $p = .51$ indicating that this effect was similar for restrained and unrestrained eaters.

Table 1. *Percentage correctly identified T2's as a function of T2 type*

	Restrained		Unrestrained	
	T2 Food	T2 Neutral	T2 Food	T2 Neutral
Lag 2	24.4 (18.4)	30.1 (17.7)	30.2 (20.2)	35.0 (23.9)
Lag 3	58.8 (20.6)	64.6 (18.3)	65.4 (16.9)	67.8 (19.3)
Lag 4	74.0 (17.7)	77.1 (14.8)	78.8 (14.9)	79.4 (14.3)
Lag 7	83.8 (13.9)	83.5 (13.7)	80.7 (10.3)	83.9 (16.5)

Do food T2 stimuli have a relatively strong interference effect on correct identification of neutral T1 specifically in restrained eaters (backward interference, first type of RSVP trials)?

Mean percentage correctly identified neutral T1s are presented in Table 2 as a function of T2 type, lag and group. The number of correctly identified T1's were subjected to a 4 (lag: 2, 3, 4, 7) × 2 (T2: type:

food, neutral) × 2 (group: restrained, unrestrained) mixed ANOVA. There were no main effects of lag, $F(3, 234) = .62$, $p = .60$ and T2 type, $F(1, 78) = 1.23$, $p = .37$. However, there was a significant T2 type × group interaction, $F(1, 78) = 4.3$, $p = .04$, $\eta^2_p = .05$, independent of lag, $F(3, 234) = 1.35$, $p = .26$. Post hoc *t*-tests showed that the restrained eaters tended to correctly identify a lower percentage of T1's with food T2s than with neutral T2s, $t(39) = 1.98$, $p = .06$, whereas a similar interference effect of food T2 was absent in unrestrained eaters, $t(39) = .86$, $p = .39$. Thus, in line with hypothesis 2, specifically in restrained eaters food T2 tended to show an interference effect which was independent of lag.

Table 2. *Percentage correctly identified T1's as a function of T2 type*

	Restrained		Unrestrained	
	T2 Food	T2 Neutral	T2 Food	T2 Neutral
Lag 2	88.3 (10.7)	89.9 (10.0)	88.1 (12.6)	87.1 (12.6)
Lag 3	88.8 (12.5)	88.6 (10.1)	87.5 (12.7)	89.3 (10.4)
Lag 4	89.3 (10.6)	90.6 (9.8)	89.4 (8.5)	87.4 (10.1)
Lag 7	87.9 (12.2)	91.4 (7.5)	89.4 (8.4)	88.4 (10.0)
Overall	88.6 (9.5)	90.1 (7.0)	88.6 (8.3)	88.1 (8.6)

Do food T1 stimuli enhance the attentional blink specifically in restrained eaters (second type of RSVP trials)?

In this variant correctly identified T2s after two types of T1 (food or neutral) were examined (see Table 3). A 4 (lag: 2, 3, 4, 7) × 2 (T1 type: food, neutral) × 2 (group: restrained, unrestrained) mixed ANOVA showed a main effect of lag, $F(3, 234) = 362.51$, $p < .01$, $\eta^2_p = .82$ indicating that participants showed an attentional blink when the time-lag between T1 and T2 was small (lags 2 and 3), whereas the blink almost disappeared when the time-lag was large (lag 7). Contrasts revealed that every lag differed from the previous lag (lag 2 vs. lag 3: $F(1, 78) = 352.38$, $p < .01$, $\eta^2_p = .82$, lag 3 vs. 4 $F(1, 78) = 97.06$, $p < .01$, $\eta^2_p = .56$, lag 4 vs. lag 7 $F(1, 78) = 34.67$, $p < .01$, $\eta^2_p = .31$). Thus the longer the lag, the more correct identifications. Most relevant for the present context, there was a main effect of T1 type, $F(1, 78) = 39.62$, $p < .01$, $\eta^2_p = .38$. Participants showed generally more difficulties to identify T2s after a food T1 than after a neutral T1. This effect varied as a function of lag, as was evidenced by a significant lag × T1 type interaction, $F(3, 234) = 6.30$, $p < .01$, $\eta^2_p = .08$. Post hoc paired sample *t*-tests showed that for all lags except for lag 7 more T2 identification errors were made when T1 was food than when T1 was neutral, all *t*s > (79) 2.62, all *p*s < .01, lag 7, $t(79) = .56$, $p = .58$, indicating that the influence of T1 on T2 is diminished after a longer time-lag. There was neither a significant T1 type × group $F(1, 78) = .37$, $p = .55$, nor a T1 type × group × lag interaction, $F(3, 234) = .94$, $p = .42$, indicating that high and low restrained eaters had similar difficulties identifying T2s following a food T1. Thus in apparent conflict with hypothesis 3, the food-induced attentional blink was not especially pronounced for high restrained eaters.

Table 3. *Percentage correctly identified T2's, as a function of T1 type*

	Restrained		Unrestrained	
	T1 Food	T1 Neutral	T1 Food	T1 Neutral
Lag 2	24.4 (21.2)	30.1 (17.7)	27.9 (25.1)	35.0 (23.9)
Lag 3	50.7 (21.3)	64.6 (18.3)	60.2 (19.1)	67.8 (19.3)
Lag 4	73.9 (19.3)	77.1 (14.8)	74.4 (14.7)	79.4 (14.3)
Lag 7	84.0 (11.5)	83.5 (13.7)	85.0 (12.4)	83.9 (16.5)

Do task-irrelevant food distractors elicit an attentional blink specifically in restrained eaters (third type of RSVP trials)?

Mean percentages of correctly identified neutral Targets after a neutral, food or threat distractor are presented in Table 4. A 2 (lag: 2, 8) × 3 (distractor type: threat, neutral, food) × 2 (group: restrained, unrestrained) mixed ANOVA showed a main effect of lag, $F(1, 74) = 42.98$, $p < .01$, $\eta^2_p = .82$. Participants were overall more accurate in identifying targets when presented at lag 8 than at lag 2 following the distractor stimulus. Thus, presenting a task-irrelevant distractor elicited an attentional blink. This effect was independent of group as evidenced by the absence of a lag × group interaction, $F(1, 78) = 0.74$, $p = .39$. Interestingly, there was a main effect of distractor type, $F(2, 156) = 6.71$, $p < .01$, $\eta^2_p = .11$. Replicating previous research, threat stimuli generally resulted in a larger blink (i.e., lower accuracy rates) than neutral stimuli, $F(1, 70) = 7.73$, $p < .01$, $\eta^2_p = .11$, which indicates that participants were distracted most by threat cues. There was no overall difference between neutral and food distractors, $F(1, 78) = .04$, $p = .83$, but the percentage correct identification after threat was lower than after food, $F(1, 78) = 9.43$, $p < .01$, $\eta^2_p = .108$. Most important for the present context, there was a significant distractor type × group interaction, $F(2, 156) = 3.61$, $p = .03$, $\eta^2_p = .12$, that appeared independent of lag, $F(2, 156) = 0.93$, $p = .40$. Contrasts indicated that for restrained eaters percentage correct after food distractors was lower than after neutral distractors, $F(1, 78) = 9.48$, $p = .03$, $\eta^2_p = .11$, whereas a similar difference was absent for unrestrained eaters, $F(1, 78) = 0.06$, $p = .81$. This is in line with hypothesis 4 and indicates that restrained eaters made, independent of lag, more errors in identifying neutral targets after a food distractor than after neutral distractors, whereas this was not the case for unrestrained eaters. There was no interaction between threat and neutral, and restraint status, $F(1, 78) = 0.06$, $p = .81$, indicating that restrained eaters are not in general more distracted by salient cues. Furthermore, there was a lag × distractor type interaction, $F(2, 156) = 6.52$, $p < .01$, $\eta^2_p = .08$, indicating that the main effect of lag differed per type of distractor. Contrasts

Table 4. *Correctly identified T2's as a function of type of distractor (D)*

	Restrained			Unrestrained		
	D: Threat	D: Food	D: Neutral	D: Threat	D: Food	D: Neutral
Lag 2	81.4 (16.5)	85.7 (12.7)	86.5 (11.4)	78.9 (19.6)	87.6 (9.9)	85.7 (9.3)
Lag 8	90.0 (8.4)	87.9 (10.5)	91.8 (8.3)	90.6 (10.3)	93.1 (7.6)	89.6 (11.1)

revealed that the effect of lag for threat differed from both neutral, $F(1, 78) = 7.71$, $p < .01$, $\eta^2_p = .09$ and food, $F(1, 78) = 9.10$, $p < .01$, $\eta^2_p = .11$, indicating that the effect of lag was most pronounced in the threat condition.

DISCUSSION

The present study was designed to investigate temporal attentional bias for high caloric food in restrained and unrestrained eaters. The major results can be summarized as follows: (i) The attentional blink was not diminished with a food T2 as compared to a neutral T2. The percentage correctly identified food T2's was even lower than that of correctly identified neutral T2's. (ii) Specifically for high restrained eaters, there was an interference effect of a food T2 on identifying the preceding neutral T1. That is, the percentage of correctly identified T1s was generally reduced with a food T2 as compared to a neutral T2. (iii) Independent of restraint status, the attentional blink was enhanced with a food T1 as compared to a neutral T1. That is the percentage of correctly identified T2s was lower with food T1s as compared to neutral T1s. (iv) Specifically in restrained eaters, task-irrelevant food cues (i.e., distractors) elicited an attentional blink. That is, for restrained eaters, neutral targets were less often correctly identified when they were preceded by a food-related as compared to a neutral distractor.

Attentional bias in the temporal dimension may consist of various components, and each of these components may play a role in the frequent undermining of dieting in restrained eaters. First, the attentional blink may be diminished when food cues appear. As a result, food cues will be identified relatively frequently. The present findings provided, however, no evidence to support this hypothesis that especially in high restrained eaters food cues would diminish the attentional blink. That is, neither high nor low restrained eaters showed a lowered threshold for identification of food cues. Disinhibited eating in restrained eaters can therefore not be explained by relatively efficiently processing of food cues. In fact, neutral cues were even more often identified than food cues. One explanation for this finding could be that the neutral category is semantically more heterogeneous than the food category. The former one is showing diverse human and non-human content and having also more pictures in its set. In turn, a more homogeneous target category (as the food picture set) is likely to produce more retrieval errors at post-trial report than a category with highly distinctive exemplars (as the neutral category). To test this post hoc explanation, in future research a comparison could be made between the within-category intrusion errors of the two categories of stimulus sets.

It seems worth noting that here is a similarity between spatial attentional bias tasks and the first type of RSVP trials of the current study (neutral T1, food vs. neutral T2). Both types of tasks examine efficient processing of food cues, which would facilitate the detection and/or identification of food cues. In the RSVP it could be that a food T2, as compared to a neutral T2, would be detected more easily, profiting from enhanced access to the cognitive system. The absence of a reduced attentional blink for food cues in the present temporal attention task seems therefore consistent with the previous failure to find differences between restrained and unrestrained eaters in spatial attention tasks such as the visual probe task and the exogenous cueing task (Ahern et al., 2010; Boon et al., 2000; Veenstra et al., 2010).

Second, another type of temporal attentional bias is the interference effect of a T2 on the identification of the preceding T1. In line with hypothesis 2, specifically in high restrained eaters food cues showed such an interference effect when presented as T2. High restrained eaters showed lower identification rates of T1 when a food T2, as compared to a neutral T2, was presented shortly afterwards. This is in line with previous research, which showed that T2 can have a detrimental influence on the identification of a preceding T1 (Potter et al., 2002). If two targets are presented in close proximity of each other, food cues might win the competition for attention because they receive prioritized access to limited attentional resources and/or are processed more elaborately in high restrained eaters, thereby overriding the previously encoded T1.

The third type of temporal attentional bias reflects the impact of prioritized processing of a T1 on people's ability to identify the T2. Supporting the view that food cues will receive prioritized processing that comes at the cost of lowering people's ability to identify subsequently presented target stimuli (cf. de Jong, Koster, van Wees, & Martens, 2010), both restrained and unrestrained eaters showed an enhanced attentional blink with a food T1 as compared to a neutral T1. This finding is in line with the elaborated intrusion theory of desire, which proposes that attention for food cues can automatically trigger intrusive thoughts. These thoughts compete with concurrent cognitive tasks through retrieval of food-related information and its retention in working memory (Kavanagh et al., 2005). However, considering that the food-induced enhanced attentional blink was not especially pronounced in high restrained eaters, this effect seems not crucially involved in high restrained eaters' difficulty to maintain their diet regimen.

Finally, the fourth type of temporal attentional bias that was examined concerns the influence of task-irrelevant cues (i.e., distractors) on people's ability to identify a subsequent neutral target. Previous research (Most, Chun, Widders, & Zald, 2005; Most et al., 2007) has shown that both positively and negatively valenced salient distractors such as nudes of the preferred sex or threat cues, may elicit an attentional blink (i.e., lower identification rates of a subsequent target). The current results indicated that specifically in restrained eaters, food distractors elicit an attentional blink. Thus even when food cues were presented as task-irrelevant distractors, these food cues nevertheless received prioritized processing in high restrained eaters. In other words, specifically in restrained eaters food items attracted attention even though these items were irrelevant for their current goal. Such non-intentional (bottom-up) tendency to prioritize the processing of food cues may help explain why restrained eaters fail so often despite their strong intention to lose weight.

If indeed the relatively strong food-induced attentional blink in high restrained eaters reflects a tendency to prioritize the processing of food stimuli, one may wonder why a similar difference between high and low restrained eaters was absent for the third type of temporal attentional bias measured, in which food cues were presented as T1 (and neutral cues as T2). Note, however, that for this third type, participants were explicitly instructed to identify food (and neutral) targets that were presented in the streams. Such explicit instruction to identify food cues might well have induced a processing strategy in low restrained eaters that is normally restricted to high restrained eaters. Thus, under condition of a top-down search for food stimuli the differential tendencies to assign processing priority to food cues may well disappear.

Independent of restraint status, people generally showed lower accuracy rates in detecting a target when preceded by a threat distractor. These findings are consistent with previous research showing that participants frequently fail to identify targets that are presented in close temporal proximity of an emotionally negative picture (Most et al., 2005) The pattern of results indicates that high restrained eaters do not show an overall increased distractibility for salient cues.

The results of the four types of RSVP trials suggest that dieting may be undermined by processes after the initial identification of food cues, rather than by relatively efficient processing of food cues. That is, the pattern of results seem to indicate that food stimuli elicit more elaborate processing in high than in low restrained eaters, which is reflected in the associated temporal attention costs. Accordingly, high restrained eaters showed an enhanced attentional blink following task-relevant as well as task-irrelevant food cues, and showed relatively poor performance in identifying neutral T1's when followed by food T2's. So specifically in high restrained eaters, food cues have a backward as well as a forward influence (even for task-irrelevant cues), implying that food cues remain relatively long in working memory. In its turn, this may give rise to craving and eventually to food intake.

To conclude, the current study was designed to investigate the role of temporal attentional bias in restrained eating. As the most critical finding the results showed that specifically in high restrained eaters, food cues get prioritized access to limited cognitive resources, even if this processing priority interferes with their current goals. This temporal attentional bias for food stimuli might help explain why high restrained eaters typically have difficulties in maintaining their diet rules (Franken, 2003).

APPENDIX

Reference numbers to images taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2001).

Threat stimuli

2800	3000	3010	3015	3030	3053	3060	3061	3062	3063
3064	3071	3100	3102	3110	3120	3130	3140	3168	3170
3261	3266	3301	3350	3550	6253	6313	6350	6560	7361
9040	9331	9405	9570	9571	9800	9810			

Neutral stimuli

1440	1450	1463	1500	1510	1540	1590	1600	1601	1602
1603	1610	1620	1630	1660	1670	1710	1720	1721	1722
1750	1810	1812	1920	1999	2050	2070	2092	2200	2214
2279	2510	5410	5470	7001	7009	7010	7016	7018	7020
7025	7030	7032	7034	7050	7052	7058	7090	7175	7211
7503	7508	7550	8501	8502	8510	8531			

Chapter 3

Heightened Attentional Capture by Visual Food Stimuli in Anorexia Nervosa

This chapter is based on: Neimeijer, R., Roefs, A., & de Jong, P. J. (2017). Heightened Attentional Capture by Visual Food Stimuli in Anorexia Nervosa. Journal of Abnormal Psychology,126, 805.

ABSTRACT

The present study was designed to test the hypothesis that anorexia nervosa (AN) patients are relatively insensitive to the attentional capture of visual food stimuli. Attentional avoidance of food might help AN patients to prevent more elaborate processing of food stimuli and the subsequent generation of craving, which might enable AN patients to maintain their strict diet. Participants were 66 restrictive AN spectrum patients and 55 healthy controls. A single-target rapid serial visual presentation (RSVP) task was used with food and disorder-neutral cues as critical distracter stimuli and disorder-neutral pictures as target stimuli. AN spectrum patients showed diminished task performance when visual food cues were presented in close temporal proximity of the to-be-identified-target. In contrast to our hypothesis, results indicate that food cues automatically capture AN spectrum patients' attention. One explanation could be that the enhanced attentional capture of food cues in AN is driven by the relatively high threat value of food items in AN. Implications and suggestions for future research are discussed.

INTRODUCTION

Anorexia nervosa (AN) is a mental disorder characterized by a fear of gaining weight despite existing underweight. According to the cognitive behavioural theory of eating disorders, the overevaluation of control over eating, shape and weight is of primary importance in maintaining the disorder (Fairburn, Cooper, Shafran, & Wilson, 2008). In line with this, it has been argued that people with AN are characterized by dysfunctional self-schemata related to body size that are reinforced by functionally related information processing biases such as attentional bias (Williamson, White, York-Crowe, & Stewart, 2004). For instance, when walking past a mirror, the attention of a person with AN might be automatically captured by disliked body parts (Glashouwer, Jonker, Thomassen, & de Jong, 2016).

Also attention to food stimuli might be biased. Experimental studies have found that when hungry, people typically show a heightened attentional bias towards food cues as indexed by both color-naming interference effects in a modified Stroop task using food versus nonfood words (Lavy & van den Hout, 1993) and automatic spatial orientation towards food stimuli in a visual probe task (Nijs et al., 2010). Such heightened attention for food cues has been argued to enhance craving, which in turn may promote further the attentional bias for food cues. Thus people may enter an attentional bias-craving cycle that eventually lowers the threshold for actual food-intake (cf. Franken, 2003).

It might, however, be that after prolonged and repeated starvation food loses its motivational salience (e.g., Veenstra & de Jong, 2011) and thereby also its attention grabbing power. If so, this may help prevent AN patients to enter this attentional bias-craving cycle and thus help them in persisting their restrictive food intake. In line with this, previous research using a free viewing task involving food stimuli found evidence for attentional avoidance of food in AN patients (Giel et al., 2011). In this task, picture pairs (food/disorder neutral) appeared on the computer screen. By means of eye-tracking methodology it was shown that AN patients spent less time looking at food pictures than comparison participants without an eating disorder. Conceptually similar results (avoidance of high-caloric food) were found in a study using a pictorial exogenous cueing task (ECT) in AN patients (Veenstra & de Jong, 2012). The ECT is a reaction time (RT)- based spatial attention task in which participants are asked to detect a visual target presented at a left or right peripheral location. In this study, the target was preceded by a task-irrelevant picture (food or disorder neutral) that in half of the trials validly cued the target's spatial location, whereas in the other half of the trials, the preceding stimulus was presented at the opposite spatial location of the target and thus invalidly cued the target's location. In line with previous research using the ECT, participants were generally faster on validly than invalidly cued trials. Yet, specifically when targets were preceded by pictures displaying high-caloric food items there was no difference in participants' response time between validly and invalidly cued trials. The finding that participants were not relatively fast on valid trials when preceded by pictures of high-caloric food, can be interpreted as a tendency to direct attention away from these food stimuli.

There is, however, also evidence that points in the opposite direction. A study using a visual dot probe task with women with various types of eating disorders found that patients exhibited attentional avoidance of pictures of low-caloric eating situations, but an approach bias with regard to pictures displaying high-caloric food situations (Shafran, Lee, Cooper, Palmer, & Fairburn, 2007). Also such visual probe task is a RT-based measure in which participants have to respond to a target (the probe), that is preceded by a task-irrelevant stimulus. A critical difference with the ECT is that in the visual probe task *pairs* of task-irrelevant stimuli are presented. In this particular study, these pairs always consisted of a nonfood and a food picture, and probes were equally often presented at the location of the preceding food as of the preceding nonfood stimulus. The tendency to direct attention away from food and/or towards nonfood stimuli (attentional avoidance) would result in relatively slow responses on trials for which the probe was presented at the same location as the preceding food stimulus as compared to trials for which the probe was presented at the opposite location of the preceding food stimulus (i.e., at the location of the nonfood stimulus). Finally, a previous study using a pictorial visual search task found increased instead of reduced distraction by high-caloric food cues in eating disorder patients compared to healthy controls (Smeets, Roefs, van Furth, & Jansen, 2008). In this task, participants were instructed to detect a neutral target word among either disorder-relevant or neutral distractor words. Slower RT's on trials with disorder-relevant than on trials with neutral distractors, indicated increased distraction by disorder-relevant words in eating disorder patients. No evidence was found for speeded detection of high-caloric food words within an array of neutral distractor pictures. Thus, overall, the existing literature does not provide a straightforward outcome.

There are several explanations for these mixed results. First, these studies used different paradigms (dot probe, ECT, visual search task, and free viewing task), and some studies (Shafran et al., 2007; Smeets et al., 2008) did not only include AN patients but also patients with bulimia nervosa (BN), binge eating disorder (BED), or eating disorder not otherwise specified (EDNOS). The eating pattern of both BN and BED patients is characterized by periods of loss of control over eating. These patients might therefore show different biases than women with AN, and this might have contributed to the finding that specifically the studies with mixed patient groups found evidence for an attentional bias toward food and distraction by food stimuli, whereas the studies with exclusively AN patients found attentional avoidance of food cues.

Secondly, all paradigms that were used in these earlier studies focused on the spatial dimension of attentional bias: the tendency to direct the visual attention towards (or away from) specific cues. Attention is, however, not only distributed over space but also over time. The visual world is bursting with information, and stimuli continually compete for a perceiver's attention: Stimuli that win often reach awareness, whereas those that lose frequently go unnoticed (Most et al., 2007). Little is known about the consequences of continued attention for food-related information for the processing of other (concurrently or subsequently appearing) information. Once a food stimulus has captured attention, it may be preferentially processed and granted prioritized access to limited cognitive resources (cf. Koster et al., 2009). Such privileged access may not only prevent new information from entering working memory but also provide the opportunity for more elaborate processing of the food stimulus, which in turn may promote craving and actual approach behaviour.

A task often used to measure the temporal dynamics of attention is the Rapid Serial Visual Presentation (RSVP) task (Raymond et al., 1992). In the single-target version of this task, a target that is preceded by a distractor has to be identified in a stream of stimuli (e.g., landscapes) that is presented in the centre of participants' attention (e.g., Most et al., 2005). These stimuli are presented in quick succession (e.g., 118 ms/stimulus) without interstimulus interval. The time window between the distractor and the target can be manipulated by adding more or fewer filler stimuli between the distractor and the target. A salient distractor can prevent the target identification if it is presented shortly before the target, even when the distractor is task-irrelevant and can be best ignored for optimal task performance. Missing the target is usually most likely to occur in the shorter time lags.

Previous RSVP studies in the context of eating disorder symptoms showed that motivational salience is an important factor in (temporal) attentional bias. Accordingly, a study comparing hungry and satiated participants showed that specifically in hungry participants, task performance was hampered when a food-distractor was presented in close temporal proximity to the target (Piech et al., 2009). Most important for the current context, it was found that this food-based temporal attentional bias is also associated with individual differences in eating behaviour tendencies. More specifically, it was found that food-distractors resulted in stronger temporal attentional bias (as indexed by hampered target identification) for restrained than for unrestrained eaters (Neimeijer, de Jong, & Roefs, 2013). Such nonintentional (bottom-up) tendency to prioritize the processing of food cues may help explain why restrained eaters fail so often despite their strong intention to lose weight. In line with this, it was found that specifically for binge eaters, food stimuli were relatively often accurately identified when presented in the 'attentional blink,' the period where information is usually missed, suggesting that food stimuli received processing priority (Schmitz, Naumann, Biehl, & Svaldi, 2015). This might enhance the chance that food elicits craving with a binge as a result.

Together, the available evidence in the context of studies that used the RSVP suggests that people who often fail in regulating their food intake (e.g., restrained eaters, patients with BED) show a preferential processing of food stimuli that interferes with their current goals. Perhaps, then, in contrast with hungry people, restrained eaters, and patients with BED, AN patients might be very efficient in preventing more elaborate processing of food stimuli and subsequent craving. If so, this would help AN patients to persist in their diet-goal. Therefore, the present study was designed to test the hypothesis that AN patients are relatively insensitive to the attentional capture of food stimuli and therefore show diminished attentional distraction by visual food cues within the context of a single-target RSVP.

METHOD

Participants

Participants were treatment-seeking female adolescents who were admitted to the Centre for Eating Disorders of Accare Child and Adolescent Psychiatry (Smilde, the Netherlands). For this study, we selected a group of restricting eaters by including a group of broadly defined AN patients (n = 66), using the Eating Disorder Examination (EDE; Bryant-Waugh, Cooper, Taylor, & Lask, 1996; Dutch version: Decaluwe & Braet, 1999). Next to patients who met all of the *DSM-IV* (American Psychiatric Association, 1994) criteria of the restrictive type of AN (n =33), we included patients who met most but not all criteria, that is, patients with menses (n = 5), with only light underweight (1-15%; n = 16), patients who were nonfat phobic AN (n = 2), and other partial AN (meeting two of four criteria, n = 10) (cf. Thomas, Vartanian, & Brownell, 2009). Age ranged from 12 to 23. For the comparison group, we selected symptom-free female adolescents (n = 55) within the same age range from secondary schools in Groningen. Educational level was determined as high or low within the Dutch system. The percentage highly educated participants in the patient and control group was 58 and 69, respectively, and this did not differ between groups, χ^2 (1, N = 119) = 0.09, p = .77.

Materials

RSVP

The RSVP was programmed in E-prime 2.0 (Schneider et al., 2002) administered on a laptop. A single-target version of the task was designed with food-related and disorder-neutral (control) distractors (Neimeijer et al., 2013). Every trial consisted of a stream of pictures that were presented for 118 ms without interstimulus interval. Each stream contained one distractor and one neutral target stimulus. Target pictures had a 10-pixel blue frame, while all other stimuli had a 10 pixel black frame. The number of pictures within a particular stream (10-19 pictures) depended on the position of the distractor and the number of stimuli between distractor and target (1 or 7) stimulus. The target was always followed by a fixed number of four fillers, to ensure that any differences in results across types of trials could not be attributed to a variable time the final target had to be kept in working memory. The order of the trials, as well as which pictures were paired with which lag, was individually randomized. The distractor was randomly presented on one of three possible positions in the stream (4, 6, 8). The target was randomly presented at Lag 2 or 8 following the distractor. In the present setup there were 2 (type of distractor: food, neutral) × 3 (T1 position: 4, 6, 8) × 2 (lag: 2, 8) = 12 different types of trials, each presented six times. See figure 1 for a visual overview of the task.

Stimuli, measuring 550 × 550 pixels, were photographs: 46 high-caloric food stimuli, 57 disorder-neutral pictures and 75 fillers (landscapes). Food pictures were derived from Istockphoto, whereas disorder-neutral photos were derived from the International Affective Picture System (IAPS). Both types of pictures were previously used in Neimeijer et al. (2013). Disorder-neutral pictures were chosen so that there was great variety and consisted of people, animals, and everyday objects like money, a book, and shoes. Food pictures consisted of a wide range of high-caloric palatable food pictures, like fries, a burger, cake, chocolate, and a pizza.

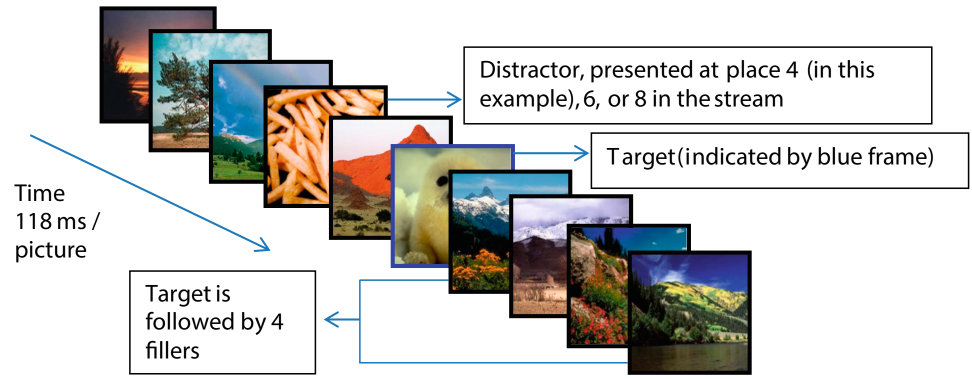

Figure 1. *Example of a single-target trial, lag 2*

The RSVP started with a four-trial practice session. Hereafter, a total number of trials were presented in three similar blocks of 24 trials, with a 30-s break between the blocks to reduce the influence of fatigue and problems with participants' concentration. After each trial, participants were asked to type what they had seen on the picture with the blue frame (targets).

Questionnaires

Eating Disorder Examination Questionnaire (EDE-Q). The child version of the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Bèglin, 1994; ChEDE-Q; Decaluwé, 1999) was administered, to allow for a comparison of eating disorder pathology between AN-like patients and healthy controls. The EDE-Q is the questionnaire version of the Eating Disorder Examination interview and consists of four subscales (0 – 6 points): restraint, eating concern, weight concern, and shape concern. The total EDE-Q score provides a global measure of the severity of eating disorder pathology.

Visual Analogue Scales. Participants' craving, liking, and participants' frequency with which they ate the food items represented on the pictures that were used in the RSVP procedure were assessed on a Visual Analogue Scale (VAS) ranging from 0 (*not at all*) to 100 (*very much/very often*). To index craving we asked: "How much do you crave this product at this moment?" Liking of food items of the tasks was assessed by answering the question: "How much do you like this product?" To assess the frequency with which they ate the particular food we asked "How frequently do you eat this product?"

Hunger Scale. The Hunger Scale (HS: Grand, 1968) consists of four items (time since last eating, subjective hunger, estimate of the amount of favourite food able to eat, estimate of time until next expected meal) and was administered to control for possible differences in hunger across groups. Since time since last eating is considered the most objective measure of hunger, this variable was used to control for the influence of hunger.

Procedure

The study was approved by the Medical Ethical Committee of the University Medical Centre Groningen, protocol number 2011.193. Before participants were scheduled for the assessment, both patients and their parents gave informed consent. After the RSVP, the VAS, and HS were filled out. Finally, height and weight were measured.

Data reduction

After the total experiment was finished, the experimenter checked whether the answers of the participants where correct (excluding typos) and specific. In order to derive a measure for temporal attentional bias, percentage correct identified targets as a function of distractor (food, neutral) and lag (2, 8) was calculated. Percentage underweight was derived from the 50th percentile of height and age.

RESULTS

Group characteristics

See Table 1 for a description of the participants and statistics of the between-groups tests. In line with the inclusion criteria, AN spectrum patients had a higher percentage underweight and higher EDE-Q scores. AN spectrum patients showed less craving, liking, and frequency of eating the foods, than healthy controls. Furthermore, AN spectrum patients reported longer time since last eating, and a trend significantly longer time until expected next meal, but less subjective hunger, and lower amount of favourite food that could be eaten right now. Eating-disordered patients and healthy controls did not differ with respect to their age.

Table 1. *Group characteristics*

	AN		Control		Between-groups test	
	M	*SD*	*M*	*SD*	*t*	*p*
Age	15.25	1.86	15.45	1.79	1.03	.31
Underweight %	17.32	9.30	-3.98	10.41	11.83	<.001
Body Mass Index	16.14	1.90	20.45	2.10	11.62	<.001
EDE-Q total score	4.09	1.26	1.24	1.03	13.15	<.001
HS- time since last meal (hrs)	8.05	8.50	1.70	1.67	4.97	<.001
HS- Subjective hunger (1-6)	2.21	1.52	3.27	1.89	4.33	<.001
HS- Amount of favourite food able to eat (1-7)	2.19	1.73	3.35	1.77	4.42	<.001
HS- time till next meal	6.47	7.03	4.92	4.52	1.66	.09

Note. Percentage underweight was derived from the 50th percentile of height and age; BMI = Body Mass Index; EDE-Q = Eating disorder Examination – Questionnaire; HS = Hunger Scale.

Temporal attentional bias

Mean percentages of correctly identified neutral targets after either a food or a neutral distractor are presented in Table 2. A 2 (lag: 2, 8) × 2 (distractor type: neutral, food) × 2 (group: AN, control) mixed

Table 2. *Percentage correctly identified targets as a function of type of distractor and lag*

Group	AN		Control	
	D: Food	D: Neutral	D: Food	D: Neutral
Lag 2	56.6 (23.6)	67.5 (17.9)	73.8 (20.4)	73.4 (18.0)
Lag 8	81.2 (16.2)	80.6 (15.8)	85.4 (13.1)	82.2 (14.1)

Note. D = distractor

analysis of variance showed a main effect of lag, $F(1, 119) = 124.31$, $p < .01$, $\eta^2_p = .51$. Participants were overall more accurate in identifying targets when presented at lag 8 than at lag 2 following the distractor stimulus. Thus, presenting a task-irrelevant distractor elicited an 'attentional blink'. Furthermore, there was a main effect of group, $F(1, 119) = 6.03$, $p = .02$, $\eta^2_p = .05$, indicating that AN spectrum patients generally showed a lower rate of accurate target identification. There was no main effect of distractor type, $F(1, 119) = 0.99$, $p = .32$, $\eta^2_p = < 0.01$, indicating that in general, participants did not have more difficulties identifying a target after a food than after a neutral distractor stimulus. Most relevant for the present context, there was a Distracter type × Group effect, $F(1, 119) = 8.63$ $p < .01$, $\eta^2_p = .07$, indicating that there was a difference between the two groups as a function of type of distracter. Independent sample *t* tests showed that there was no difference between the two groups in percentage correctly identified pictures after a neutral distracter, $t(119) = 1.43$, $p = .16$, $d = .26$, but there was a difference in performance on trials with a food distracter, $t(119) = 3.10$, $p < .01$, $d = .57$. AN spectrum patients were more distracted by food cues, thereby hampering subsequent target detection. Although the effect seemed most pronounced for lag 2, the Distracter type × Group × Lag interaction was not significant, $F(1, 119) = 2.05$, $p = .16$, $\eta^2_p = .02$. The effect remained stable if controlled for hunger (using time since last eating as a covariate), $F(1, 119) = 8.40$, $p < .01$, $\eta^2_p = .05$, so the effects cannot be attributed to more hunger in the patient group. See Figure 2 for a visual presentation of the results. In order to further explore the relationship between eating disorder symptoms and RSVP performance, difference scores were calculated (percentage correct identified food pictures minus percentage correct identified neutral pictures) for both lags, thereby

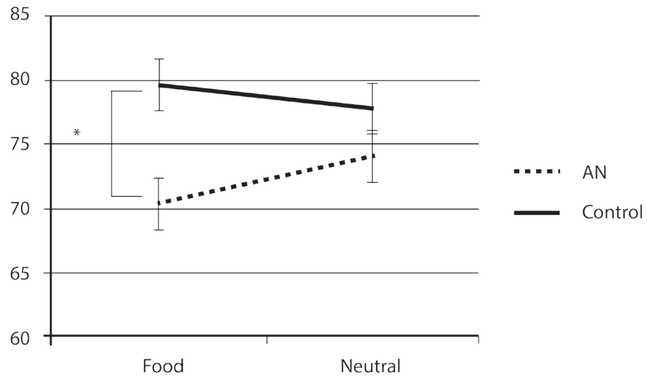

Figure 2. *Percentage correctly identified targets as a function of distracter type.*

controlling for general RSVP performance. Negative scores indicate an attentional bias for food stimuli. This RSVP difference score for Lag 2 was significantly associated with all EDE-Q subscales: restraint, $r(121) = -.21$, $p = .02$; eating concerns, $r(121) = -.23$, $p = .01$; weight concerns, $r(121) = -.19$, $p = .04$; and shape concerns, $r(121) = -.23$, $p = .01$, indicating that more severe eating disorder symptoms were associated with a stronger attentional bias. There were no significant correlations between EDE scores and the difference scores for Lag 8, all $rs(128) < -.05$, all $ps > .60$.

DISCUSSION

The present study was a first attempt to investigate temporal attentional bias for food in AN spectrum patients. The results clearly indicate that in AN spectrum patients target detection is hampered when it is preceded by a food distractor and that more severe eating disorder pathology is associated with a stronger attentional bias for food cues. Thus, in contrast with the hypothesis, AN spectrum patients showed a bottom-up attentional capture by visual food cues that interfered with their current task (i.e., target identification). This is in line with some earlier studies on (spatial) attentional bias that also showed heightened distraction by food stimuli in eating disorder patients (Shafran et al., 2007; Smeets et al., 2008).

The hypothesis that food has lost its attention grabbing power in AN spectrum patients (e.g., through prolonged starvation and repeated exposure to food without consequently eating) is not supported by these findings. In fact, prolonged food deprivation might have led to an even stronger attentional bias for food. The addiction account of attention states that there is a reciprocal relationship between attention for food and craving (Nijs et al., 2010). The current finding that AN spectrum patients show attentional capture by food stimuli might then reflect heightened craving in these patients. Also earlier studies link temporal attentional bias and craving (Piech et al., 2009; Neimeijer, 2013; Schmitz et al, 2015). AN patients show an attentional bias but do not get caught in the attentional bias- craving - eating cycle. This seems to imply that they have high self-regulation skills to resist food-related short-term reinforcement that runs counter to their diet-goal. In other words, it seems that (attentional) avoidance of food cues in AN is not so much sustained by attenuated automatic attentional capture but reflects processes involving more top-down control.

The heightened attentional capture might also be driven by the threat value of food. That is, food cues might not only be salient because of their hedonic value but, especially in AN, also because of their threatening associations with gaining weight and losing control over eating. Indeed, previous research consistently found that negative stimuli (e.g., trauma reminders) can capture and hold attention, as well as hamper ongoing task performance (e.g., Most et al., 2005; Olatunji, Armstrong, McHugo, & Zald, 2013; Verwoerd, Wessel, & de Jong, 2010). When a fear-associated stimulus is detected, processing resources are automatically diverted from less salient cues to these feared stimuli in order to escape the danger as quickly as possible. Hyperattention to feared stimuli can, therefore, facilitate an early escape (Lavy, van den Hout, & Arntz, 1993). Although there was no significant effect for lag in the current study, the effect seemed most prominent when the distractor was presented in close temporal proximity of the target (Lag 2). The correlational analysis also showed that stronger attentional bias in Lag 2 was associated with more severe eating disorder pathology. This might indicate that there is an initial vigilance for food cues, and that attention bias is 'recovered' on the longer lag (see also Most et al., 2005). It could also be that even a subsequent avoidance is shown, a pattern that is also seen in the context of anxious concerns (e.g., Mogg, Bradley, Miles, & Dixon, 2004).

An attentional bias for food in AN might thus reflect fear of gaining weight or losing control over eating and could contribute to dietary restraint and (behavioural) avoidance of food stimuli. It might, however, also be that the threat for AN patients is approaching the food and giving in to the craving they may experience. As earlier described, especially for underweight participants the prolonged food deprivation and the basic organismic need for nutrition might have led to an attentional bias for food, which in turn may lower the threshold for nonintended food consumption. In the meantime, a quick detection of food cues may also help to quickly escape from stimuli or contexts that signal food-intake, thereby supporting their ongoing diet goal.

The current pattern of findings cannot be attributed to a generally worse performance of AN spectrum patients in the RSVP task, because the difference between patients and the control group was restricted to food distracters. Also the presence of hunger does not explain the differences, as the main results remained unaffected when we statistically controlled for hunger. However, it should be mentioned that ongoing food deprivation may not be fully captured by time since last meal or subjective hunger.

AN spectrum patients did also more generally show lower identification rates than healthy controls which may be caused by underweight, as underweight is known to influence cognitive processes as thinking and concentration (Keys, Brožek, Henschel, Mickelsen, & Taylor, 1950). Because restrictive food intake is in particular a feature of the restricting AN, we only included this subtype. Therefore, the results cannot be generalized to all AN patients (i.e., the binge/purging subtype). It seems plausible that binge/purging individuals may show the same pattern of finding, but future research is necessary to test this.

To conclude, in this study temporal attentional bias in a large group of AN spectrum patients was tested. Patients showed heightened distraction by food cues, which might indicate that food cues are highly salient. It remains unclear whether this means that AN spectrum patients do experience automatic craving for food (as an analogue with addiction) or that food has a high threat value (as an analogue with anxiety), or both (when the threat is approaching the food and give in to craving). In addition, an important next question is whether biased attention for food is an epiphenomenon when having eating concerns or has also a causal relationship with these concerns. A first step to examine whether it contributes to the maintenance of the disorder would be to test if the temporal attentional bias would normalize under influence of (successful) treatment and if a (more pronounced) bias predicts worse treatment outcome.

Chapter 4

Automatic Approach Tendencies towards High and Low Caloric Food in Restrained Eaters: Influence of Task-Relevance and Mood

This chapter is based on: Neimeijer, R. A. M., Roefs, A., Ostafin, B. D., & de Jong, P. J. (2017). Automatic Approach Tendencies toward High and Low Caloric Food in Restrained Eaters: Influence of Task-Relevance and Mood. Frontiers in Psychology, 8, 525.

ABSTRACT

Although restrained eaters are motivated to control their weight by dieting, they are often unsuccessful in these attempts. Dual process models emphasize the importance of differentiating between controlled and automatic tendencies to approach food. This study investigated the hypothesis that heightened automatic approach tendencies in restrained eaters would be especially prominent in contexts where food is irrelevant for their current tasks. Additionally, we examined the influence of mood on the automatic tendency to approach food as a function of dietary restraint. An Affective Simon Task-manikin (AST) was administered to measure automatic approach tendencies where food is task-irrelevant, and a Stimulus Response Compatibility task (SRC) to measure automatic approach in contexts where food is task-relevant, in 92 female participants varying in dietary restraint. Prior to the task, sad, stressed, neutral, or positive mood was induced. Food intake was measured during a bogus taste task after the computer tasks. Consistent with their diet goals, participants with a strong tendency to restrain their food intake showed a relatively weak approach bias towards food when food was task-relevant (SRC) and this effect was independent of mood. Restrained eaters showed a relatively strong approach bias towards food when food was task-irrelevant in the positive condition and a relatively weak approach in the sad mood. The weak approach bias in contexts where food is task-relevant may help high-restrained eaters to comply with their diet goal. However, the strong approach bias in contexts where food is task-irrelevant and when being in a positive mood may interfere with restrained eaters' goal of restricting food-intake.

Keywords: approach tendencies, approach bias, mood, restrained eating, dieting

INTRODUCTION

Restrained eaters try to restrict their food intake to control their weight, but typically have difficulties with this and often indulge in the food they want to avoid, eventually leading to weight gain (Herman & Polivy, 1980). This raises the question as to what mechanisms underlie this seemingly inconsistent behaviour. Current dual process models (Hofmann, Friese, & Strack, 2009) propose that behaviour is determined by two different cognitive systems that may differentially affect people's eating behaviours. The 'reflective system' is assumed to be responsible for voluntary and largely controlled behaviours, and is assumed to be predictive in situations with enough cognitive resources. The 'impulsive system' is responsible for impulsive, automatic behaviours in situations with less cognitive capacity. The impulses are thought to emerge from associations that are based on experience (Hofmann et al., 2009). For example, a person may repeatedly experience a stimulus (e.g., chocolate), followed by a behaviour (e.g., putting the chocolate in one's mouth) and then a consequent emotional response to the behaviour (e.g., pleasure). As a result, the mere sight of a chocolate may then automatically elicit positive associations and the tendency to approach the stimulus. These associative processes, need no attentional resources to function, and are independent of whether a person consciously endorses or rejects the implication of an associative link (Gawronski & Bodenhausen, 2006; Hofmann et al., 2009; Strack & Deutsch, 2004).

The tendency of restrained eaters to overeat might be mediated by positive automatic associations with food. Especially in conditions of impaired self-control, automatic associations may have a stronger influence on behaviour than more deliberate processes. The positive association with food might express itself in automatic approach tendencies, the behavioural tendency to approach or avoid food. As a consequence, these processes might drive them to overeat. For instance, negative affect/stress might impair rational processes, and thereby reduce the ability to resist immediate relief in favor of long-term benefits (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). This might help explain why restrained eaters, despite their strong wish to control their eating behaviour (deliberate process), so often fail.

Indeed, it has been shown that positive associations with high-caloric food may complicate the restriction of food-intake (Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008). However, evidence for the idea that especially high-restrained eaters show positive associations, is mixed (see: Roefs et al., 2011). On the one hand, studies using various indirect measurement paradigms provided evidence indicating that restrained eaters show a positive association with high caloric food (Hoefling & Strack, 2008; Houben, Roefs, & Jansen, 2010). In a similar vein, a study on the automatic behavioural tendency to approach or avoid stimuli as a measure for positive associations with food items have shown that restrained eaters have stronger automatic approach tendencies towards food stimuli than unrestrained eaters (Veenstra & de Jong, 2010). On the other hand, one study did not find a relationship between implicit measures of positive attitudes toward high caloric food and restraint status (Roefs et al., 2005). Furthermore, other studies even found opposite results, indicating stronger negative attitudes toward high caloric food in restrained eaters compared to unrestrained eaters

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(Maison et al., 2001; Papies, Stroebe, & Aarts, 2009). Also a study using a computerized reaction time task in which participants had to approach or avoid food with a joystick, found that dieters showed less approach tendencies towards high caloric food words compared to non-dieters (Fishbach & Shah, 2006).

One possible explanation for the inconsistencies in earlier findings resides in methodological differences. Firstly, the studies used different measures to determine restrained eating. Some used the Restraint Scale (RS; Herman & Polivy, 1980) whereas other studies relied on the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijters, Bergers & Defares, 1986), which might measure slightly different concepts. For instance, weight fluctuation (actual influence of intention on behaviour) is measured in the RS, but not in the DEBQ. In addition, some studies measuring positive associations with food used tasks in which food was task-relevant and where one has to approach or avoid a stimulus on the basis of the absence/presence of food-content (Fishbach & Shah, 2006), whereas others used a task in which food was task-irrelevant and where one has to approach or avoid a stimulus on the basis of a food-irrelevant feature of the picture (e.g., Veenstra & de Jong, 2010). For instance, participants have to approach or avoid the picture on the basis of the perspective of the picture (top view/ side view) and the content of the picture (food/nonfood) is not relevant for defining a correct response. The Stimulus Response Compatibility task (SRC; De Houwer et al., 2001), is an example of a task-relevant measure, where the content of the picture (i.e., food/non-food) is relevant to the task. That is, the correct response on each trial is defined by whether a stimulus contains food or not (e.g., participants are instructed to approach food and to avoid nonfood). Thus, the participant is actively categorizing pictures as either food or non-food stimuli. The Affective Simon Task manikin version (AST; de Houwer et al., 2001) is an example of a task-irrelevant measure, where response requirements depend on stimulus features that are unrelated to the food/non-food content of the pictures, such as the orientation of the stimulus (top versus side view of the object on the picture; e.g., Veenstra & de Jong, 2010). Thus in this case, a participant does not have to categorize a stimulus as food or non-food for giving a correct response (approach or avoid). A participant could, for example, be instructed to approach top view pictures by moving the manikin towards the picture and to avoid side view pictures by moving the manikin away the picture. Though food versus nonfood is task-irrelevant in the AST, the absence/presence of food-content systematically varies over trials, and therefore the effect of the task-irrelevant food vs. non-food content of the pictures on reaction times can be analysed.

Previous studies examining the relevance of automatic approach tendencies in the context of dysregulated eating behaviour used the SRC and the AST interchangeably (Fishbach & Shah, 2006; Veenstra & de Jong, 2010). However, both tasks may assess different aspects of participants' automatic approach tendencies. Because food is relevant to the task in SRC, this task could model situations where the person is deciding what and how much to eat, such as during a common mealtime. Especially when high caloric food items elicit strong automatic approach tendencies, this may have an influence on people's food selection that is inconsistent with their diet goal. Conversely, because food is irrelevant to the task in AST (i.e., the response has to be based on another feature than food/nonfood), this task could model situations where the person is performing a different task, such as walking to work, but is tempted to eat, for example, by the smell of bread at the bakery. Thus, in both types of situations, automatic approach tendencies towards high caloric food might interfere with one's goal to restrict food intake. Yet, especially in the latter context, where the non-food relevant task taxes available sources for cognitive control, the impact of automatic approach tendencies might be relatively large and may eventually lead to overeating (high caloric food) in spite of one's diet goal.

A second explanation for these inconsistent findings in studies on restrained eating and approach tendencies may be that implicit measures of associations do not reflect a fixed phenomenon but instead are highly context dependent and vary as a function of, for instance, mood. If, for example, a person has learned to eat in situations of negative affect or stress, then negative affect might become automatically associated with eating. Accordingly, high stress levels may elicit stronger automatic approach tendencies for food in restrained eaters. Consequently, self-control may break down and it may drive them to overeat, especially in those situations of negative affect/stress. Various studies have indeed demonstrated that restrained eaters increase their food consumption in response to a negative mood (e.g., Vanderlinden et al., 2004; Yeomans & Coughlan, 2009). Moreover, in contrast to unrestrained eaters, restrained eaters have shown an increase in food intake after various stressful events, such as social stressors (e.g., public speaking), ego-threatening stressors (e.g., unsolvable puzzles linked to intelligence) and daily hassles (see for a review Greeno & Wing, 1994).

However, other lines of research suggest that sadness can induce more analytic and deliberative processing (e.g., activates the slow, deliberative system), whereas happy mood is related to more superficial and automatic judgments. For example, there is evidence that a happy mood is associated with increased automatic stereotyping, (which is presumed to be based upon implicitly held associations: Schwarz & Bless, 1991). This would suggest that especially a positive mood might automatically activate food-approach associations. In line with this, several studies point to increased food intake during positive emotions for eating- or weight concerned people (e.g., emotional and restrained eaters). A study on emotional eating and mood showed a significant increase in food intake for emotional eaters in the positive compared to the neutral condition (Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013). Moreover, unsuccessful dieters were found to be vulnerable for increased eating in response to positive emotions (Yeomans & Coughlan, 2009). Accordingly, it has been argued that positive mood might be an underestimated risk factor for dysregulated (over)eating (Bongers et al., 2013).

Furthermore, it is hypothesized that both positive and negative mood might be involved in craving and intake (Baker et al., 1986). Negative-affect craving would be triggered by a negative emotional response or aversive events, whereas the positive-affect craving system would be activated by positive emotional states or cues paired with eating and its pleasurable or positively reinforcing effects. When activated, both the positive and the negative affect system could induce craving experiences, approach behaviour, affect, and corresponding physiological reactions. In line with this, a study showed that restrained eaters showed increased food intake both in negative and positive mood states (compared with neutral mood) (Cools, Schotte, & McNally, 1992). Taken together, there is evidence that both a negative and a positive mood may promote food intake in restrained eaters. So, both in a positive and in a negative mood (compared to a neutral mood) approach tendencies may be enhanced.

In sum, the present study examined: 1) whether restrained eaters show automatic approach tendencies towards food when food is task-relevant and/or when food is task-irrelevant, and 2) whether the effects vary as a function of caloric value and 3) whether mood has an effect on automatic approach tendencies towards food, subjective craving, and actual food intake, and whether these mood effects are most pronounced for restrained eaters.

METHOD

Participants

Considering that weight concerns and dieting behaviour are more prevalent among women than men (Schaumberg & Anderson, 2016) only female participants were recruited. Participants were recruited from a participant-pool consisting of undergraduate psychology students and an (on-line) paid participant-pool administered by the University of Groningen. We included 92 female participants (M = 21.5 years, SD= 2.14) who received either course credit or money (11 Euro for 1.5 hours) as a compensation for participating in our study. Prior to testing, participants were screened for depressive symptoms with the Major Depression Inventory (MDI, Bech, Rasmussen, Olsen, Noerholm, & Abildgaard, 2001). Five of the 92 participants scored above the diagnostic threshold of meeting at least five of the DSM-IV (American Psychiatric Association, 1994) criteria (including sad mood or loss of interest). They completed the study, but were assigned to a positive or neutral mood induction (because a negative mood induction could pose a mental health risk to depressed individuals), and were later removed from the data because randomization was violated. See table 1 for a description of the participants.

Stimulus selection

Stimuli for the AST and the SRC tasks were adapted from Veenstra and de Jong (2010), with some modifications. The stimuli consisted of eight high-caloric food pictures (pizza, croissant, chocolate, chips, fries, ice-cream, cookie, and toast with ham and cheese), eight low-caloric food pictures (strawberries, melon, carrots, cherries, cucumber, tomato, apple, bell pepper), and eight neutral stimuli (various office items). For the AST and the SRC two different stimuli sets were used. For the AST, two different pictures (380 × 285 pixels) were constructed for each type of these food items: one displaying the food from a top view and one from a side view. Pictures were shown in a way it was clear whether it was top view or side view (e.g., showing it on a plate).

Materials

Computer tasks

To test if restrained eaters' automatic approach tendencies are most pronounced when food is task-irrelevant (AST; cf. Veenstra & de Jong, 2010), or whether approach tendencies might also be non-intentionally activated in conditions when food is task-relevant, the current study included both types of tasks. Both high and low caloric food pictures were included to explore whether the effect would be most pronounced with high caloric food pictures. The computer tasks were programmed in E-prime 2.0 (Schneider et al., 2002) and administered on a Windows XP computer with the screen resolution set to 1280 by 1024 pixels.

AST. As an index of automatic approach tendencies we used a manikin task that was based on the AST originally developed by De Houwer (2001). The AST was adapted from Veenstra and de Jong (2011) with minor modifications, including switching the language of instructions from Dutch to English. Each trial started with a 1000-ms presentation of a fixation dot. Next, a picture appeared in the middle of the screen, and a black manikin appeared above or below the picture. Participants in the AST-manikin had to move the manikin towards or away from the picture by (repeatedly) pressing the arrow buttons. The picture remained on the screen until the manikin had reached the picture or the edge of the screen. The required response (move towards or away) was defined by the perspective of the picture (top-view versus side-view). The content of the stimuli (high-caloric food, low-caloric food, or neutral pictures) was a task-irrelevant stimulus feature and could thus be ignored by the participant for correct task-performance.

The AST consisted of a practice block of eight trials, followed by two test blocks of 96 trials each. Trials differed in stimulus type (i.e., task-irrelevant feature: high caloric, low caloric, and neutral), the side from which the photograph was taken (i.e., task-relevant feature: top-view vs. side view), and position of the manikin (i.e., above or below the picture). Each stimulus was presented four times in each block (top view: manikin above; top view: manikin below; side view: manikin above; side view: manikin below). For each participant, trials were presented in a unique random order. Half of the participants were instructed to move the manikin towards top views and away from side views, and half of the participants were instructed to move the manikin towards side views and away from top views. Furthermore, participants were instructed to move the manikin as fast and accurately as possible.

SRC. The SRC task was programmed and executed in a similar way as the AST. The central difference was that in the SRC, participants had to approach or avoid according to the content of the picture (i.e., food vs. non-food). The participants were instructed to approach food (high and low caloric) and avoid non-food items in one block, whereas the response assignment was reversed in the other block (avoid food and approach non-food items). The order of the blocks was balanced over participants: Half of the participants had to approach food in the first block, and avoid in the second. For the other half of the participants, the instructions were reversed (first avoid food, then approach it). The food SRC consisted of two practice blocks with four trials each and two test blocks of 96 trials each.

Mood Induction

To control for mood and test whether mood would influence automatic approach tendencies and eating, a mood induction was carried out. Earlier research often used a sad mood induction, but other dimensions of a negative mood, as for instance stressed mood, may also be involved. Therefore, four mood conditions were used (sad, stressed/anxious, positive, and neutral). The mood induction included imagery and music components. The imagery component of the mood induction was adapted from Sinha et al. (2009). Participants were instructed to identify and write about a situation and about what they had experienced in the described event. Participants in the neutral condition had to write about a typical day. They were asked to describe both the environmental details of the event / day and emotions that they experienced during the event. After writing about these details, participants were presented with a list of bodily sensations (e.g., heart pounds, breathes faster) and were instructed to indicate which of these they had experienced in the event they just described. Participants imagined the event for five minutes with instructions to imagine the event as if it was happening in the present. While imagining the event, participants also listened to music corresponding to the mood condition. The music used in this experiment has been shown to be effective for mood inductions in previous studies (e.g., Bradley, Garner, Hudson, & Mogg, 2007). Participants in the positive mood condition listened to Grieg's 'Morning Mood' from 'Peer Gynt' while those in the neutral condition listened to 'Neptune' from Holst's 'The Planets.' In the sad mood induction, participants listened to 'Russia under the Mongolian Yoke' by Prokofiev at half speed, and participants in the stressed/anxious mood condition listened to 'The Rite of Spring' by Stravinsky.

Taste test

Food intake was examined with a bogus 'taste test'. In this task participants were instructed to taste several kinds of high caloric snack foods and judge the food on various aspects such as quality and saltiness. Unbeknownst to the participants, total food intake was measured (in grams). The food consisted of four high-caloric snacks: chocolate nuts (508 Kcal/100g), potato chips (545 Kcal/100g), rice crackers with chocolate (376 Kcal/100g), and salty sticks (490Kcal/100g). The snacks were presented in white plastic food containers that were placed in a box on the participant's table. The box was closed so that participants were unable to see the snacks before the taste test began. Participants were told that the researchers were interested in their taste perception at that moment to reduce suspicion that their food intake would be calculated afterwards. They were given seven minutes to complete questions about the food's taste and quality (e.g., "How would you judge the quality of the potato chips?"; "To what extent do you think the potato chips are salty?"). Participants were told they could taste as much as they wanted during the task. Participants were allowed to eat as well during the subsequent tasks until the end of the experiment. Throughout the taste task, participants listened to the music linked to their mood condition (as described above). The food was weighted before and after the experiment to calculate the total amount of food that was consumed.

Questionnaires

Restraint scale. Dietary restraint was assessed by the Restraint Scale (Herman & Polivy, 1980). The scale consists of 10 items (e.g., "How often are you dieting?") and its scores range from 0 to 35, with five questions ranging from one to four, and five questions ranging from one to three. Higher scores refer to attempts to control weight.

Visual analogue scales (VAS). As a subjective measure of approach tendencies, participants' craving for food stimuli was assessed. Furthermore, participants' liking, as well as participants' frequency with which they ate the food items represented in the pictures that were used in the implicit measurement procedures, were assessed. To index craving we asked: "How much do you crave this product at this moment?" Liking of food items of the AST was assessed by answering the question: "How much do you like this product?". To assess the frequency with which they ate the particular food we asked "How frequently do you eat this product". The questions were answered on a VAS ranging from 0 (not at all) to 100 (very much/very often).

Mood questionnaire. To measure the current mood state, participants indicated on a scale from one (very slightly or not at all) to five (extremely) how much they felt that way right now, that is at the present moment, in response to 15 mood-describing adjectives. Three adjectives were taken to describe each (except neutral) mood condition (positive: happy, glad, elated; sad: sad, down, depressed; stressed: stressed, on the edge, nervous), and six unrelated mood adjectives (e.g., proud) derived from the PANAS scale (Watson, Clark, & Tellegen, 1988) were added.

Procedure

See Figure 1 for an overview of the experiment. Participants were asked to abstain from eating for one hour before the experiment. To control for a decreased desire to eat sweets early in the morning as compared to the rest of the day, the study took place in the late morning and afternoon. Participants were tested in groups of a maximum of six participants. On arrival, they completed the informed consent form. The participants were randomly assigned to the positive, neutral, sad, or stressed/ anxious mood condition. Participants were seated next to each other, but were separated by partition walls so they could not see each other. They were asked to wear headphones throughout the experiment to ensure that they could not hear each other and would be focused on the tasks.

At the beginning of the experiment, participants completed the mood questionnaire to assess their current mood state. Then, participants followed the mood induction as described above. After this, participants performed the AST. The AST was administered first (before the SRC), because we anticipated less carry-over effects from a task with food as task-irrelevant feature to a task with food as a task-relevant feature than vice versa (eg., Bosson, Swann, & Pennebaker, 2000). Next, participants completed the mood questionnaire for a second time to verify the effectiveness of the

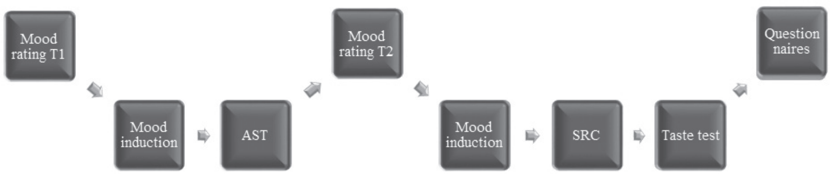

Figure 1. *An overview of the experiment*

mood manipulation. This was done after the AST to minimize the time between the induction and the computer task, and thus to optimize the influence of the mood manipulation on task performance. As a booster of the condition-relevant mood, participants were then asked to repeat parts of the first mood induction. This time, the mood induction took three minutes and involved re-living the situation and listening to the music from the first mood induction. Then, participants completed the SRC. Subsequently, participants performed the taste task to assess their level of food consumption. They were given seven minutes to complete the food ratings. The condition-specific music continued during the taste task. Next, participants completed the RS. Then, they were asked how much they liked, wanted, and how often they consumed each of the food items that were represented in the pictorial AST and SRC tasks. Finally, participants' weight and height were measured, to calculate their Body Mass Index.

Data reduction

Reaction times (time until first response) were used in the analyses. Trials of the AST and the SRC task with reaction times below 200 ms and trials with errors (trials in which the first response was in the wrong direction; 21 and 12% for respectively the AST and SRC) were excluded from the analysis in order to have meaningful trials (following Veenstra & de Jong, 2010). To limit the influence of outliers, the median reaction times per condition per participant were used in the data analysis.

Approach biases were calculated by subtracting reaction times of approach trials from reaction times of avoidance trials for each stimulus type separately (high caloric food, low caloric food, neutral pictures). To calculate the approach biases for high and low caloric food, we subtracted the approach bias of neutral pictures from the approach bias of high caloric and low caloric food pictures, respectively. A positive approach bias indicates a tendency to approach food pictures and a negative approach bias (avoidance bias) indicates a tendency to avoid food pictures.

RESULTS

Group characteristics

Participants in the four mood conditions did not differ in age, BMI, RS, liking for high or low caloric food, wanting for or frequency of eating high and low caloric food, happiness, sadness, and stressed mood, see Table 1.

Manipulation check

See Table 2 for mean mood scores. To assess differences in mood between the four mood conditions after the manipulation (T2), data were analysed in a 3 (mood T2 rating: happiness, sadness, and stressed mood) × 4 (condition: positive, stressed, sad, neutral) mixed ANOVA. There was an interaction effect of mood rating × condition, $F(6, 162) = 2.73$, $p = .02$, $\eta^2_p = .09$. Post hoc tests indicated that participants in the sad mood condition generally reported higher sadness than participants in the positive condition, $t(40) = 3.07$, $p < .01$, $d = .97$, whereas participants in the positive condition reported higher happiness scores than in the sad, $t(40) = 2.15$, $p = .04$, $d = .68$, and the stressed condition $t(40) = 2.06$, $p = .04$. $d = .65$.

Table 1. *Group characteristics of the different mood groups*

	Positive (*n* = 22)	Neutral (*n* = 23)	Stressed (*n* = 21)	Sad (*n* = 21)	Between groups tests	
					F	*p*
Age	21.81 (2.51)	21.41 (1.97)	20.88 (1.69)	22.00 (2.42)	0.82	.49
BMI	21.31 (2.13)	21.96 (3.88)	23.32 (4.28)	22.21 (2.64)	0.84	.48
RS score	12.82 (4.86)	13.13 (4.96)	14.81 (6.05)	13.81 (6.09)	0.55	.65
Liking HC	38.81 (7.93)	38.74 (9.24)	40.24 (7.32)	37.90 (7.97)	0.30	.83
Liking LC	31.72 (5.04)	31.30 (6.03)	31.19 (5.01)	28.81 (8.88)	0.90	.44
Wanting HC	29.04 (9.40)	23.82(11.78)	25.52(10.75)	28.10 (8.29)	1.22	.31
Wanting LC	28.14 (7.74)	25.35 (7.59)	24.62 (4.95)	23.52 (8.87)	0.91	.44
Frequency HC	27.09 (6.05)	28.13 (7.21)	26.52 (6.41)	24.76 (8.53)	0.86	.47
Frequency LC	27.50 (5.89)	27.52 (6.45)	27.05 (6.59)	25.29 (7.66)	0.54	.66
Stressed T1	1.97 (0.84)	1.83 (0.67)	2.04 (0.70)	2.17 (0.64)	0.49	.69
Sadness T1	1.64 (0.99)	1.37 (0.79)	1.54 (0.64)	1.36 (0.46)	0.37	.78
Happiness T1	2.82 (0.64)	2.87 (1.05)	2.46 (0.59)	2.64 (0.82)	0.41	.75
Total amount eaten	39.09 (26.73	30.05(29.16)	32.19(18.20)	32.43(18.22)	0.60	.62

Note. Mean characteristics, with *SD* in parentheses; HC = high caloric, LC = low caloric, BMI = body mass index, RS = restraint scale. T1 is prior to the mood induction.

Table 2. *Means of stressed, sad, and happy mood ratings for each mood condition.*

	Mood condition			
Mood rating	Stressed	Neutral	Happy	Sad
Stressed	1.84 (0.87)^{a}	1.68 (0.77)^{a}	1.54 (0.52)^{a}	1.83 (0.92)^{a}
Sadness	1.44 (0.54)^{ab}	1.55 (0.86)^{ab}	1.21 (0.36)^{a}	1.87 (0.93)^{b}
Happiness	2.19 (0.80)^{a}	2.38 (0.79)^{ab}	2.65 (0.64)^{b}	2.21 (0.70)^{a}

Note: Mean scores with standard deviations in parenthesis for T2 rating (after mood induction and AST). Means are based on a five-point rating scale (ranging from 1= very slightly or not at all to 5= extremely). Mean values with the same superscript letters in each row were similar and no statistically significant differences were observed.

AST approach bias for high caloric and low caloric food

Means of the median reaction times for each mood condition are presented in Table 3 and errors percentages in Table 4. AST approach bias scores of the reaction times were subjected to a 2 (food type: HC, LC) × 4 (mood condition: positive, sad, stressed, neutral) mixed ANCOVA with centred RS as a covariate. Overall, participants showed an approach bias towards food, compared to neutral pictures, as was evidenced by a significant intercept, $F(1, 74) = 3.81$, $p = .05$, $\eta^2_p = .08$. There was no main effect of mood, $F(3, 74) = 0.55$, $p = .65$, $\eta^2_p = .02$, food type, $F(1, 74) = 0.004$, $p = .95$, $\eta^2_p =$

Table 3. *Mean AST reaction times as a function of mood*

	Stressed	Neutral	Positive	Sad
High caloric food				
Approach	787 (160)	799 (169)	759 (147)	793 (122)
Avoid	911 (186)	904 (155)	869 (126)	908 (137)
Low caloric food				
Approach	766 (186)	760 (164)	755 (125)	782 (151)
Avoid	901 (181)	864 (143)	876 (131)	873 (122)
Neutral stimuli				
Approach	814 (166)	820 (158)	817 (167)	863 (137)
Avoid	938 (182)	901 (172)	889 (165)	903 (138)
AST Bias scores HC	1 (170)	24 (151)	38 (189)	76 (116)
AST Bias scores LC	10 (187)	23 (174)	49 (125)	53 (202)

Note. Means of the AST median reaction times and bias scores in ms, with SD in parenthesis. Approach biases were calculated by first subtracting reaction times of approach trials from reaction times of avoidance trials for each stimulus type separately (high caloric food, low caloric food, neutral pictures) and subsequently, subtracting the approach bias of neutral pictures from the approach bias of both high caloric and low caloric food.
AST = Affective Simon Task, manikin version. HC = high caloric, LC = low caloric.

Table 4. *Mean AST error percentages as a function of mood*

	Stressed	Neutral	Positive	Sad
High caloric food				
Approach	13.52 (8.21)	14.19 (7.92)	13.86 (8.07)	14.16 (5.35)
Avoid	28.33 (14.21)	23.81 (9.85)	28.28 (11.69)	23.11 (14.13)
Low caloric food				
Approach	14.95 (8.33)	13.95 (9.45)	12.19 (9.55)	12.68 (9.74)
Avoid	34.38 (14.68)	30.19 (13.67)	28.57 (14.26)	27.58 (14.39)
Neutral stimuli				
Approach	16.62 (7.61)	19.14 (10.99)	17.47 (8.15)	15.16 (10.46)
Avoid	29.48 (13.07)	27.48 (13.39)	23.71 (8.17)	23.42 (14.99)
AST Bias scores HC	3.10 (10.88)	4.95 (9.94)	3.62 (8.99)	1.00 (7.64)
AST Bias scores LC	1.67 (10.75)	5.19 (11.58)	5.29 (11.14)	2.47 (8.44)

Note. Means of the AST errors and bias scores, with SD in parenthesis. Approach biases were calculated by first subtracting amount of errors of approach trials from amount of errors of avoidance trials for each stimulus type separately (high caloric food, low caloric food, neutral pictures) and subsequently, subtracting the approach bias of neutral pictures from the approach bias of both high caloric and low caloric food.
AST = Affective Simon Task manikin version, HC = high caloric, LC = low caloric.

<.01, or of restraint, $F(1, 74) = 0.003$, $p = .96$, <.01. However, there was a significant mood × restraint interaction $F(3, 74) = 3.64$, $p = .02$, $\eta^2_p = .13$, that was independent of food type, as was evidenced by the absence of a mood × restraint × food type interaction, $F(3, 74) = 1.19$, $p = .32$, $\eta^2_p = .05$.

To examine the source of the mood × restraint interaction, the correlations between AST approach bias scores and RS-scores were compared across the various mood-conditions with a t-test after a Fisher r-to-z transformation. The correlation between AST (HC and LC combined) and level of dietary restraint in the positive mood ($r = .40$) differed from the correlation in the neutral ($r =$

-.37), $z = 2.43$, $p < .01$ and sad mood ($r = -.36$), $z = 2.31$, $p = .02$. There were no significant differences between the other mood conditions, all $z < 1.64$, all *ps* > .10. This indicates high that restrained eaters showed relatively strong approach tendencies for food in a positive mood, whereas low restrained eaters showed relatively strong approach tendencies in a neutral and sad mood.

SRC approach bias for high and low caloric food

Means of the median reaction times for each mood condition are presented in Table 5 and error percentages in Table 6. SRC approach bias scores of the reaction times were subjected to a 2 (food type: HC, LC) × 4 (mood condition: positive, sad, stressed, neutral) mixed ANCOVA with centred RS as a covariate. Overall, participants showed an approach bias towards food, compared to neutral pictures as was evidenced by a significant intercept, $F(1, 75) = 26.15$, $p < .001$, $\eta^2_p = .26$. There was no main effect of mood, $F(3, 75) = 1.05$, $p = .38$, or food type, $F(1, 75) = 0.15$, $p = .70$, $\eta^2_p > .01$ but the effect of restraint was significant, $F(1, 75) = 4.59$, $p = .04$, $\eta^2_p = .06$, indicating that high restrained eaters generally showed less approach tendencies (or more avoidance) than low restrained eaters. There was no significant mood × restraint interaction effect $F(3, 75) = 1.22$, $p = .31$, $\eta^2_p = .05$, but there was a trend of food type × mood × restraint interaction, F (3, 75) = 2.43, $p = .07$, $\eta^2_p = .09$, suggesting that the mood × restrained interaction may differ for both food types. Two ANCOVA's (for both high and low caloric food) with mood condition as a between group variable, centred RS as a covariate and SRC approach bias as dependent variable were conducted to examine the source of this possible interaction. Only for high caloric food the RS × mood interaction was significant, $F(4, 78) = 2.77$, $p = .03$, $\eta^2_p = .12$. Low restrained participants showed relatively weak approach tendencies for high caloric food in the positive mood and relatively strong approach tendencies in the stressed mood while an opposite pattern seemed present in high restrained participants (i.e., relatively weak approach during stressed mood and relatively strong approach tendencies during positive mood).

Table 5. *Mean SRC reaction times as a function of mood*

	Stressed	Neutral	Positive	Sad
High caloric food				
Approach	568 (79)	574 (140)	551 (73)	597 (108)
Avoid	629 (90)	640 (93)	661 (92)	652 (105)
Low caloric food				
Approach	559 (85)	546 (75)	560 (85)	578 (114)
Avoid	622 (71)	613 (96)	662 (71)	651 (93)
Neutral stimuli				
Approach	652 (80)	625 (86)	652 (80)	670 (109)
Avoid	671 (71)	655 (83	671 (71)	641 (75)
SRC Bias scores HC	43 (155)	36 (217)	110 (92)	83 (125)
SRC Bias scores LC	44 (130)	36 (127)	85 (96)	101 (130)

Note. Means of the SRC median reaction times and bias scores in ms, with SD in parenthesis. Approach biases were calculated by first subtracting reaction times of approach trials from reaction times of avoidance trials for each stimulus type separately (high caloric food, low caloric food, neutral pictures) and subsequently, subtracting the approach bias of neutral pictures from the approach bias of both high caloric and low caloric food.
SRC = Stimulus response compatibility task, HC = high caloric, LC = low caloric.

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Table 6. *Mean SRC error percentages as a function of mood*

	Stressed	Neutral	Positive	Sad
High caloric food				
Approach	7.15 (6.64)	8.75 (6.41)	9.00 (8.68)	8.90 (8.69)
Avoid	17.35(13.85)	12.70 (10.26)	13.59 (11.73)	14.10 (9.69)
Low caloric food				
Approach	5.70 (8.57)	5.25 (6.37)	7.68 (6.80)	5.05 (6.39)
Avoid	16.80 (12.26)	17.50 (10.32)	14.91 (10.50)	11.19 (9.41)
Neutral stimuli				
Approach	17.35 (10.99)	18.20 (12.68)	15.41 (10.00)	17.86 (14.26)
Avoid	15.40 (13.62)	13.65 (13.51)	12.09 (6.96)	16.76 (15.38)
SRC Bias scores HC	10.20 (11.81)	9.68 (13.33)	6.43 (12.12)	9.58 (16.37)
SRC Bias scores LC	11.65 (13.47)	13.42 (16.22)	8.48 (8.30)	13.32 (16.53)

Note. Means of the SRC errors bias scores, with SD in parenthesis. Approach biases were calculated by first subtracting amount of errors of approach trials from amount of errors of avoidance trials for each stimulus type separately (high caloric food, low caloric food, neutral pictures) and subsequently, subtracting the approach bias of neutral pictures from the approach bias of both high caloric and low caloric food. SRC = Stimulus response compatibility task, HC = high caloric, LC = low caloric.

Craving and food intake

See Table 1 for mean food intake scores for the different mood groups and craving (wanting) scores. Craving scores and food intake during the taste test were subjected to three ANCOVA's with condition (positive, sad, stressed, neutral) as a between-subjects factor, RS as a covariate, and craving (high and low caloric food) and food intake as dependent variables. There were no main effects of mood or restraint on participants' craving of high and low caloric food or total food intake, nor interaction effects of mood × restraint, all $Fs(3, 78) < 2.54$, all $ps > .12$.

Table 7. *Correlations between approach bias, craving, restraint scale, BMI and amount eaten*

	AST HC	AST LC	SRC HC	SRC LC	Craving HC	Craving LC	RS	BMI	Total amount eaten
AST HC		.75**	.06	-.04	.26*	-.14	-.02	-.21	.20
AST LC			.14	.05	.28*	.21	.02	-.12	.13
SRC HC				.77**	.35**	.19	-.27*	-.27*	.16
SRC LC					.33**	.05	-.21	-.28*	.09
Craving HC						.06	-.17	-.38**	.09
Craving LC							.01	-.04	.07
RS								.36**	-.15
BMI									-.21*

Note. Positive bias scores indicate stronger approach tendencies towards food. AST = Affective Simon Task-manikin version; SRC = Stimulus Response Compatibility task; HC = high caloric; LC = low caloric; RS = restraint scale; BMI = body mass index.

** p < .05.*

*** p < .01.*

Relationships between approach tendencies, craving, and food intake

To explore the overall relationships between approach tendencies, subjective craving, and actual food intake we computed (two-tailed) correlations (see Table 7). There was a positive relationship between AST approach bias for high caloric food and craving for high caloric food. Also for the SRC there was as a positive relationship between approach bias for high caloric food and craving.

There was a trend towards a significant relationship between AST approach bias for high caloric food and total amount eaten during the taste task, $r(81) = .20$, $p = .07$. There was no significant relationship between AST approach bias for low caloric food and food intake, neither for the SRC high and low caloric food. Finally, attesting to the relevance of differentiating between approach-avoidance tasks in which food is task-relevant versus tasks in which food is task-irrelevant, the SRC and AST indices showed only a very weak association that was not statistically significant.

DISCUSSION

The current study examined to what extent automatic approach tendencies towards food are influenced by both positive and negative mood, and whether the impact of these mood states would be pronounced in participants with relatively high dietary restraint, and especially evident for high caloric food, thereby interfering with the diet-goal of restrained eaters. The major findings were (i) overall, whether the task was food-relevant or not, participants showed a tendency to approach food rather than avoid it; (ii) when food was task-relevant, restrained eaters demonstrated less approach toward food; (iii) in the positive mood condition and when food was task-irrelevant, restrained eating was associated with stronger approach tendencies toward high caloric food; (iv) there was a positive relationship between approach bias for high caloric food and subjective craving both when food was task-relevant and task-irrelevant; (v) there was a trend positive relationship between actual food intake during the taste task and approach bias for high caloric food, when food was task-irrelevant.

Restrained eating and approach bias

Approach bias measured with the AST was not unconditionally related to restrained eating. The finding that the AST approach bias for high and low caloric food was not generally heightened in participants with relatively high scores on the Restraint Scale seems inconsistent with the previous finding that especially restrained eaters showed a heightened approach bias for food as indexed by the AST (Veenstra & de Jong, 2010). However, there were several differences between the study of Veenstra and de Jong (2010) and the current study, which might help explain the differences in outcomes. Most important, in the current study, participants underwent a mood induction prior to the AST, which influenced the approach bias (see below).

In the SRC, there was a negative relationship between restrained eating and approach bias: low restrained eaters generally showed a stronger approach bias (or less avoidance) than high restrained eaters. This is in line with previous research showing that restrained eaters displayed less approach bias when automatic approach tendencies were measured with a task in which food was a task-relevant feature (Fishbach & Shah, 2006). This indicates that the SRC-task more closely reflects behaviour consistent with their dieting goal.

Mood and approach bias

Positive and negative mood induction differentially affected the relationship between dietary restraint and the approach tendencies towards food in contexts where food was task-irrelevant (i.e., as indexed by the AST). Following a positive mood induction, restrained eating was associated with stronger approach tendencies towards food, whereas in the sad mood condition, this effect was reversed (i.e., the higher the RS score the less the approach bias for food). For the SRC, results point in the same direction, but only for high caloric food. This is in line with several studies pointing to increased food intake during positive emotions for eating- or weight concerned people (e.g., emotional and restrained eaters; Bongers et al.; Yeomans & Coughlan, 2009).

One testable explanation of why positive emotions may lead to food indulgence is that happiness produces more impulsive and non-reflective processing. Especially in restrained eaters this may lead to heightened approach behaviour inconsistent with conscious intentions (Schwarz & Bless, 1999). In other words, especially in restrained eaters, a positive mood might activate food-approach associations.

Following a negative mood induction, restrained eating was negatively correlated with automatic approach tendencies towards food. This seems inconsistent with earlier studies on mood and eating showing that a negative mood leads to increased food intake in restrained eaters (e.g., Schotte, Cools, & McNally, 1990). However, a distinction can be made between approach tendencies and actual eating. Possibly, both a positive and negative mood could lead to eating in restrained eaters, but eating in a negative mood might be more due to intentional processes (in order to improve mood), whereas eating in a positive mood might be more strongly under the influence of more automatic processes such as automatic approach tendencies.

The present findings suggest that people by default (not restrained) show a heightened approach tendency toward food when in a negative mood. Food might play a role in affect regulation. The affect regulation model posits that dysphoric individuals eat in an effort to provide comfort or distraction from negative emotions (Stice, Presnell, Shaw, & Rohde, 2005). If food is regularly consumed to end a negative feeling then eating will become associated with aspects of the preceding negative state (Deutsch & Strack, 2006). One explanation of why this sad mood did not lead to stronger approach tendencies in high restrained eaters, might be that especially for this group the sad mood might have heightened the accessibility of negative associations with food-intake (e.g., weight gain) thereby promoting avoidance instead of approach of food.

Approach bias, craving, and food intake

There was no effect of mood and restraint on actual food intake. This is inconsistent with prior research (Schotte et al., 1990), which showed that negative affect triggered overeating in restrained eaters. There are, however, several differences between the studies, including the mood induction procedure (watching a frightening film vs. listening to sad music) and the measure of food intake, which might explain the differences in outcomes.

There was a positive relationship between craving for high caloric food and both approach bias as measured with the SRC and the AST, thereby supporting the validity of the tasks. Although both tasks were significantly correlated with craving, there was no significant relationship between the SRC and the AST food approach indices. The finding is in line with the idea that each of these tasks measures approach bias in different types of contexts; and are also predictive for different real life situations. The finding that previous studies on approach bias in restrained eating showed apparently inconsistent results, might therefore (at least partly) be due to the fact that different paradigms were used: food as a task-irrelevant (e.g., Veenstra & de Jong, 2010) vs. food a task-relevant feature (e.g., Fishbach, 2006).

Approach bias for high and low caloric food was highly correlated within tasks, and there was no interaction effect between food type and mood on approach tendencies. This indicates that there is an effect of food in general and not of specifically high or low caloric food. The relationship between approach bias and actual eating during the taste task was only present (as a non-significant trend) in the AST. In the taste task the participant was instructed to complete questions about the taste and quality of the food. In this task eating the food itself was not task-relevant because someone might be less actively thinking about the question whether to choose/ approach the food or not, and how much to eat. The food may nevertheless elicit automatic approach tendencies towards food thereby leading to more food intake. The AST, in which the food is task-irrelevant, might thus better mimic approach behaviour during the current taste task than the SRC-task. The mood induction did not directly result in differences in food intake. Possibly, the mood manipulation or the taste task was not sufficiently sensitive, and future studies are needed to further explore the relationship between mood and actual food intake.

Limitations and future research

In the current study, a design was chosen with a fixed order of the two computer tasks measuring approach bias. As described earlier, this was chosen because we anticipated less carry-over effects from a task with food as task-irrelevant feature to a task with food as a task-relevant feature than vice versa. Prolonged exposure to food items might possibly enhance the vulnerability for bottom-up interference of food item tasks, especially in restrained eaters. Or, in contrast, this exposure could lead to habituation and consequently effects of the computer tasks will be less pronounced. Since the AST was administered first in all participant, the possible influence would only be present in the SRC. Because an approach bias effect was found in SRC, even for unrestrained eaters, the habitation hypothesis seems not very plausible. To study carry-over effects and influence of time, a design with a balanced instead of a fixed order of computer tasks could be used in future studies.

Although differences were found between the various mood states in interaction with individual differences in restraint status, an analysis of the effectiveness of the mood induction did not show that the neutral condition differed significantly from the other conditions in self-reported mood states. One explanation for this could be that the mood ratings were completed after the ASTs and did not immediately follow the mood induction procedure. The effects of the mood induction might have been high initially, but might have decreased over time, resulting in back to normal levels of self-reported mood states. The finding that automatic approach tendencies did vary as a function of mood condition supports this view. The most plausible explanation for the differential effects is a change of mood by the mood induction. There were several reason for choosing this design instead of a mood rating directly after the mood indication. Firstly, this mood procedure had been shown effective in various previous studies (e.g., Werthmann et al., 2014), so there was no reason to assume that this would be different in the current study. Secondly, reflecting on mood could possibly influence the mood state itself. We anticipated that with doing the AST immediately following the mood induction the effect of the mood induction would be maximized.

A limitation of the current study is that our sample was predominantly lean and young, so findings cannot be generalized to overweight/obese participants or to a wide age range. Secondly, we did not compare groups receiving course credits vs. money. Although there seem no strong reasons to assume that both types of reimbursement would result in different response patterns, we cannot rule this out. Furthermore, the current study lacked sufficient power to detect small effects. Therefore, it seems important to replicate the current findings in a larger sample with adequate power to also reliably detect relatively small effects of both the mood induction and participants' restrained status. Lastly, the design of the study to answer the question whether approach bias was associated with craving and actual eating was suboptimal because the mood induction possibly caused extra variance.

Conclusion

The current study showed that, in line with dietary goals, high-restrained eaters displayed less approach tendencies than low restrained eaters when food was task-relevant. However, when in a positive mood and when food was task-irrelevant, automatic approach tendencies were heightened, which may interfere with restrained eaters' goal of restricting food-intake. Thus, specifically outside regular mealtimes positive mood might lower the threshold for overeating in restrained individuals.

Chapter 5

Reduced Automatic Approach Tendencies towards Task-Relevant and Task-Irrelevant Food Pictures in Anorexia Nervosa

This chapter is based on: Neimeijer, R. A. M., Roefs, A., Glashouwer, K. A., & de Jong, P. J. (2017). Reduced Automatic Approach Tendencies towards Task-Relevant and Task-Irrelevant Food Pictures in Anorexia Nervosa. Submitted for publication.

ABSTRACT

Objective. Anorexia nervosa (AN) patients are characterized by excessive and often life-threatening restriction of their food intake. A crucial question is how AN-patients succeed in maintaining this excessive and persistent food restriction even when resulting in a state of starvation. This study zoomed in on one possible mechanism, and tested the hypothesis that their ability to restrain from food might be facilitated by a reduced automatic approach tendency towards food, in both meal and non-meal contexts. To model a meal context, we used a paradigm in which food was task-relevant and could not be ignored. To model the seductive properties of food outside a meal context, we used a paradigm in which food was task-irrelevant and should thus be ignored for optimal task performance.

Methods. Two versions of a computerized approach-avoidance task were administered in adolescent restrictive AN spectrum patients ($n = 63$), and in a healthy comparison group of adolescents without eating pathology ($n = 57$): A Stimulus Response Compatibility (SRC) task with food as a task-relevant feature, and an Affective Simon Task (AST) with food as task-irrelevant feature.

Results. In both tasks, AN spectrum patients showed reduced approach tendencies for high caloric food stimuli compared to the comparison group. Only the SRC uniquely predicted the presence of AN.

Discussion. Reduced automatic approach tendencies towards food in both meal and non-meal contexts may contribute to AN-patients' ability to persistently restrict their food-intake and may be critical targets for optimizing treatment.

INTRODUCTION

Anorexia nervosa (AN) is characterized by a low body weight and a fear of gaining weight. Patients show a disturbance in the way their body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight (American Psychiatric Association, 1994). A critical question is how AN patients manage to succeed in maintaining a restrictive eating pattern, while they actually are in a state of starvation. Food generally has a high reward value, even more for people who have been deprived of food (Stroebe, Papies, & Aarts, 2008), yet individuals with AN manage to overcome the habitual biological drive to eat. One explanation for the successful restriction of food intake in AN patients might be that AN patients show a weakened automatic approach response towards food. This is consistent with studies on neurocircuit function in eating disorders suggesting that premorbid traits and brain functioning might underlie successful dieting behaviour (Kaye, Fudge, & Paulus, 2009). Subsequently, food deprivation in general and avoidance of high fat food specifically becomes a habit that is a self-reinforcing process: the habit is rewarding while requiring little cognitive effort (Walsh, 2013).

A critical situation in which food may typically elicit automatic approach tendencies is when people are exposed to food items during regular meals. During a regular meal, one has to choose what and how much to eat, and in such a context, automatic approach tendencies may affect both the selection of food (e.g., automatic approach tendencies may be stronger for high than for low caloric food items) and the amount of food-intake. However, in successful dieters, explicit exposure to food in the context of regular meals will probably activate their diet goal (Stroebe et al., 2008), which in turn may elicit automatic avoidance tendencies that override the common automatic inclination to approach food items. If, indeed, in the context of regular meals patients with AN, who can be considered extremely successful dieters, show reduced automatic food-induced approach tendencies or even avoidance instead of approach, this would help explain why patients with AN are so well-able to persist in restricting their food-intake.

An approach-avoidance task in which food is relevant to determine the correct response, can be seen as a model for approach-avoidance tendencies in a regular meal context. So far, no studies into automatic approach tendencies were conducted in AN patients in which food stimuli were included as a task-relevant feature. However, one study compared automatic approach/avoidance tendencies of dieters (participants who indicated that they sometimes engaged in dieting) and non-dieters in the general population (Fishbach & Shah, 2006, study 2). Outcomes showed that, consistent with their diet goal, dieters were indeed faster in pushing than pulling food words (avoidance) with a joystick in a computer task, whereas the opposite was found for the non-dieters (approach). However, this study has several limitations. First of all, the study relied on verbal stimuli which may be suboptimal to automatically activate approach behaviours as words typically lack the perceptual features of food that may elicit the seductive tendencies to approach food (cf. Huijding & de Jong, 2006). In addition, food words were compared to fitness words, so it remains unclear whether the effect was present due to avoidance of food, or approach of fitness, or both. Lastly,

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because the study included non-clinical, healthy dieters, it is unknown whether similar or even stronger avoidance patterns may exist in AN patients. Therefore, in the present study we focused on a clinical group of AN patients and patients with Eating Disorder Not Otherwise Specified with specific characteristics of AN (from now on called AN spectrum patients). We used pictures of food (instead of words) to assess approach-avoidance tendencies in a task where food was task-relevant and could thus not be ignored. Thus, the first aim of this study was to test whether AN spectrum patients would show reduced automatic approach or even avoidance tendencies when food is used as a task-relevant feature (as a model of a regular meal situation) in the context of a speeded reaction time measure with the responses to a neutral control stimuli (office items) as the reference category instead of fitness-related stimuli.

Automatic approach or avoidance of food might not only be relevant in the context of common mealtimes, but may also exert its influence in situations where food is irrelevant for one's current tasks. For example, while doing something else (e.g., reading a book), a person may be tempted to eat by the smell or the sight of particular food items. In AN spectrum patients, food may also fail to elicit an automatic approach response in situations like this. If so, this would render AN spectrum patients also less sensitive to the seducing properties of food stimuli outside the context of common meal times. In line with this idea, a previous study among adolescents found that individuals with AN indeed showed weaker automatic approach tendencies towards pictures of both high and low caloric food items than healthy controls in an approach avoidance task with food as a task-irrelevant feature (as a model of a non-meal context) (Veenstra & de Jong, 2011). A recent study among adult patients with AN showed a similar pattern that was most pronounced for high caloric food items. Whereas controls showed a clear approach bias toward food, AN patients did not show such a bias (Paslakis et al., 2016). Therefore, the second aim of this study was to test the robustness of these prior findings indicating that AN patients would show reduced automatic approach tendencies towards food when food is irrelevant for the task at hand (as a model of meal-irrelevant contexts). Moreover, the study examined to what extent reduced approach tendencies when food is task-irrelevant vs. task-relevant may independently contribute to the persistence of AN.

In sum, the current study was designed to enhance our understanding of why AN is so persistent, and how patients succeed in maintaining their dieting behaviour even in a condition of starvation. Therefore, we tested if AN spectrum patients (i) show reduced automatic approach or even avoidance tendencies for specifically high caloric food when food is a task-relevant feature; (ii) show reduced approach tendencies for specifically high caloric food when food is a task-irrelevant feature; and (iii) we examined to what extent both types of approach/avoidance tendencies are independently related to AN.

METHOD

Participants

Participants were female adolescents who were all admitted to a specialized Centre for Eating

Disorders of Accare, the Netherlands. For this study, we included a group of adolescent eating disorder patients with AN spectrum symptomatology (*n* = 63), using the Eating Disorder Examination (EDE: Bryant-Waugh et al., 1996; Decaluwé, 1999). Data collection started before the DSM-5 was published, so inclusion criteria of the DSM-IV were used (American Psychiatric Association, 1994). Next to patients who met all of the criteria of the restrictive type of AN (*n* = 33), we included patients who met most but not all criteria: patients with menses (*n* = 5), patients who were only mildly underweight, that is less than 15 % (*n* = 14), patients who were nonfat phobic AN (*n* = 2), and other partial (meeting 2/4 criteria) AN (*n* = 9) (cf. Thomas et al., 2009). Age ranged from 12 to 23. For the comparison control group, we selected healthy adolescents (*n* = 57) from secondary schools in Groningen.

Materials

Computer tasks.

The present study included two versions of a computerized speeded approach-avoidance task. The computer tasks were programmed in E-prime 2.0 (Schneider et al., 2002) administered on a laptop.

Stimulus Response Compatibility task (SRC). In the SRC version, the content of the picture (i.e., food/non-food) was a task-relevant feature (De Houwer et al., 2001). This task was designed to assess participants' automatic tendency to approach food when explicitly exposed to food items as during a common meal.

Each trial started with a 1000-ms presentation of a fixation dot. Next, a picture appeared in the middle of the screen, and a black manikin appeared above or below the picture. Participants had to move the manikin towards or away from the picture by (repeatedly) pressing the arrow buttons. The picture remained on the screen until the manikin had reached the picture or the edge of the screen. The participants were instructed to approach food (high caloric) and avoid non-food items in one block, whereas the response assignment was reversed in a second block (avoid food and approach non-food items). The order of the blocks was balanced over participants: Half of the participants had to approach food in the first block, and avoid in the second. For the other half of the participants, the instructions were reversed. A relatively strong automatic tendency to avoid food under these conditions would express itself in relatively fast responses and or less errors when the required response is to avoid the food items, together with relatively slow responses and/or more errors when the required response is to approach the food items. The SRC consisted of two practice blocks with four trials each (with stimuli not used in the test blocks) and two test blocks of 64 trials each. For each participant, trials were presented in a unique random order.

AST. In the Affective Simon task (AST) version of the approach avoidance task, the correct response was determined by stimulus features that were unrelated to the food/non-food content of the pictures, namely the orientation of the stimulus (top versus side view) of the object in the picture (De Houwer et al., 2001). This task might therefore be considered as a lab-model for approach-avoidance tendencies in situations where a person is not about to eat, but in which food may nevertheless automatically elicit automatic approach or avoidance response.

The AST consisted of a practice block of eight trials (with stimuli not used in the test blocks), followed by two test blocks of 96 trials each. Trials differed in stimulus type (i.e., task-irrelevant feature: high caloric, low caloric, and neutral), the side from which the photograph was taken (i.e., task-relevant feature: top-view vs. side view), and position of the manikin (i.e., above or below the picture). Each stimulus was presented four times in each block (top view: manikin above; top view: manikin below; side view: manikin above; side view: manikin below). For each participant, trials were presented in a unique random order. Half of the participants were instructed to move the manikin towards top views and away from side views, and half of the participants were instructed to move the manikin towards side views and away from top views.

Stimulus selection

Stimuli for the AST and the SRC tasks were adapted from Veenstra and de Jong (2011) with some modifications. For both tasks, the stimuli represented eight high-caloric food items (pizza, croissant, chocolate, crisps, chips, ice-cream, biscuit, and toast with ham and cheese), and eight neutral stimuli (various office items). For the AST, two different pictures (380 × 285 pixels) were constructed for each of these items: one displaying the item from a top view and one from a side view. Although high caloric food items were most critical for the current study, the AST that was used in the previous study (Veenstra & de Jong, 2011), also contained low-caloric food items. For optimizing the comparability of findings we therefore decided to also include pictures representing low-caloric items in the current AST (strawberries, melon, carrots, cherries, cucumber, tomato, apple, paprika).

Questionnaires

Eating disorder Examination interview (EDE-Q). The child version of the Eating Disorder Examination Questionnaire (Fairburn & Bèglin, 1994) was administered, to allow for a comparison of severity of eating disorder pathology between AN spectrum patients and healthy controls.

Hunger Scale. The Hunger Scale (Grand, 1968) consists of four items (time since last eating, subjective hunger, estimate of the amount of favourite food able to eat, estimate of time until next expected meal).

Procedure

Approval for the study was given by the Medical Ethical Committee of the University Medical Centre Groningen, protocol number 2011.193. Patients in the study were diagnosed by the child version of the Eating Disorder Examination (Decaluwé, 1999). The child version was also used for the participants above 18, for uniformity reasons. The differences between the child and adult version are very little, only the wording is adapted to make it more suitable for adolescents. Before participants were scheduled for the assessment, both patients and their parents gave informed consent. Measurement took place before start of the treatment. The order of the computer tasks was counterbalanced over participants. Half of the participants received first the SRC and the other half first the AST. After the computer tasks, patients completed the questionnaires. Finally, weight and height were measured. Percentage underweight was derived from the 50th percentile of height and age (TNO, 2010).

Data reduction

Automatic approach tendencies might express themselves in response latencies and errors, and therefore both are used in the analysis. For the response latencies analyses, time until first key press was used. For the error-analysis, trials of which the first response was in the wrong direction were identified as errors. Before calculating mean reaction times, error trials and trials with response latencies below 200 ms and above 2000 ms were excluded from analyses (e.g., Veenstra & de Jong, 2010).

SRC and AST-effect scores were computed by subtracting error percentages and response latencies of approach trials from corresponding avoidance trials (cf. Rinck & Becker, 2007). Higher scores are indicative of an automatic tendency to approach rather than to avoid pictures, and negative effects reflect a tendency to avoid rather than to approach pictures. Subsequently, approach bias was calculated by subtracting SRC- and AST-effects for neutral pictures from respectively SRC- and AST- effects for high and low (for the AST) caloric food items, hereby controlling for non-specific differences in approach and avoidance tendencies. Higher scores on approach bias refer to a tendency to approach food compared to neutral pictures.

Analyses

To test whether AN spectrum patients show reduced automatic approach or even avoidance tendencies, for the SRC, independent samples *t*-tests were conducted to test the difference between AN spectrum patients and the healthy control group. To control for the possible influence of current hunger, an ANCOVA was done using time since last eating as a covariate (as it is the more objective measure for current hunger). For the AST, 2 (stimulus type: high caloric, low caloric) × 2 group (AN, control) repeated measures ANOVA's were conducted with both errors and response latencies bias scores. Again, the same analysis was done with time since last eating as a covariate, to control for hunger. Relevant interactions were followed up by t-tests. To examine the independent predictive value of both tasks, a backward logistic regression analyses was conducted with AN (yes/no) as dependent variable and SRC and AST High caloric errors and response latencies bias scores as predictors.

RESULTS

Group characteristics

See Table 1 for a description of the participant characteristics and statistics of the between groups tests. In line with the inclusion criteria, AN spectrum patients had a higher percentage underweight (range 0-38 %), and higher EDE-Q scores. In addition, AN spectrum patients reported longer time since last eating, a longer time until expected next meal, but less subjective hunger, and lower amount of favourite foods that could be eaten right now.

Automatic approach tendencies measured with the SRC (food as task-relevant feature)

Error rates

See Table 2 for mean response latencies and error percentage of the SRC. There was no difference

Table 1. *Group characteristics*

	AN		Control		Between-groups test	
	M	*SD*	*M*	*SD*	*t*	*p*
Age	15.21	1.85	15.49	1.83	0.83	.41
Underweight %	17.62	9.29	-3.68	10.24	11.85	< .001
Body Mass Index	16.11	1.93	20.37	2.13	11.42	< .001
EDE-Q total score	4.04	1.32	1.17	0.99	13.00	< .001
HS- time since last meal (hrs)	8.00	8.49	1.89	2.15	5.29	< .001
HS- Subjective hunger (1-6)	2.19	1.48	3.39	1.8	3.99	< .001
HS- Amount of favourite food able to eat (1-7)	2.05	1.69	3.54	1.80	4.67	< .001
HS- time till next meal (hrs)	9.28	11.86	4.38	4.35	2.95	< .01

Note. Percentage underweight was derived from the 50th percentile of height and age; EDE-Q = eating disorder examination – questionnaire; HS = hunger scale.

Table 2. *SRC Percentage errors and response latencies as a function of group and stimulus*

	AN patients		Healthy controls	
	HC	Neutral	HC	Neutral
Percentage errors				
Approach	13.51 (14.22)	12.38 (10.82)	7.40 (6.86)	16.16 (13.91)
Avoidance	17.62 (15.74)	20.87 (15.12)	13.09 (13.91)	21.21 (17.76)
Reaction time				
Approach	638 (176)	663 (126)	611 (137)	721 (242)
Avoidance	697 (144)	717 (140)	745 (287)	707 (140)

Note. SRC = stimulus response compatibility task, AN = anorexia nervosa, HC = high caloric.

between the AN spectrum patients and the control group $t(118) = 1.05$, $p = .30$, $d = .19$. Moreover, the bias scores for both the AN spectrum group, $t(62) = 1.30$, $p = .20$, $d = .33$, and for the control group, $t(56) = 0.19$, $p = .85$, $d = .05$, did not deviate significantly from zero (see Figure 1B).

Response latencies. Patients showed less approach tendencies for food than healthy controls, $t(118) = 2.30$, $p = .02$, $d = .42$. The effect remained stable when corrected for hunger, $F(1, 117) = 5.06$, $p = .03$, $\eta^2_p = .04$. A one sample t-test showed that the approach bias score differed from zero for controls, $t(56) = 2.76$, $p < .01$, $d = .74$, but not for AN spectrum patients, $t(62) = 0.17$, $p = .87$, $d = .04$. Thus, whereas controls showed an approach bias for high caloric food, patients showed no such bias (see Figure 1D).

Automatic approach tendencies measured with the AST (food as task-irrelevant feature)

Error rates

See Table 3 for mean response latencies and error percentage of the AST. The ANOVA showed a

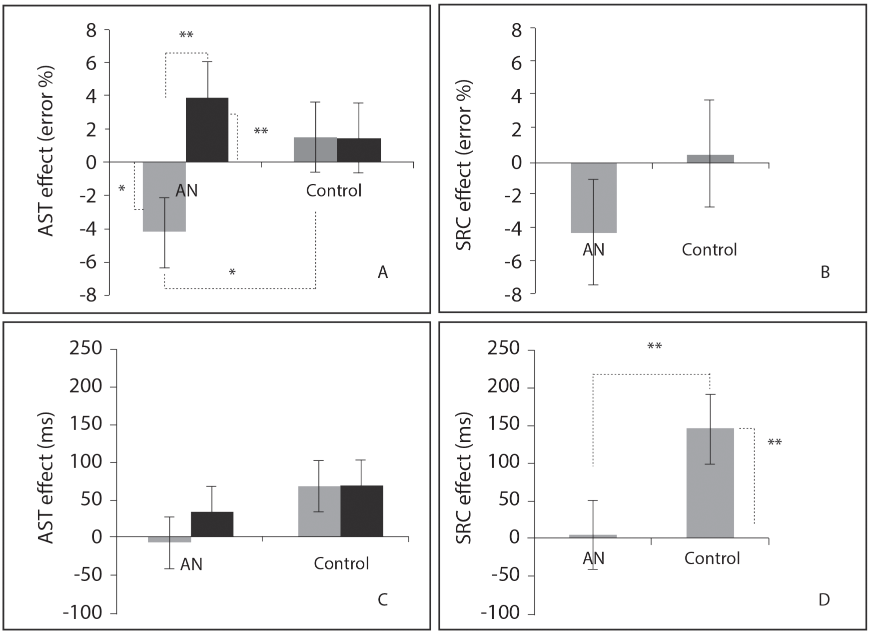

Figure 1. *AST and SRC effects of response latencies and error scores. Higher scores indicate an approach tendency for food. Error bars represent +/- 1 standard error of the mean. * = p = trend sign, **= p < .05.* ■ *= high caloric* ■ *= low caloric*

Table 3. *AST Percentage errors and response latencies as a function of group and stimulus*

	AN patients			Healthy controls		
	HC	LC	Neutral	HC	LC	Neutral
Percentage errors						
Approach	16.90 (13.26)	14.30 (9.82)	17.70 (9.94)	14.89 (10.52)	14.56 (10.94)	17.19 (9.64)
Avoidance	24.76 (14.52)	30.25 (14.87)	29.78 (16.19)	29.21 (14.61)	28.82 (16.99)	29.98 (14.97)
Reaction time						
Approach	841 (246)	787 (229)	831 (213)	845 (304)	850 (313)	928 (492)
Avoidance	942 (198)	929 (212)	941 (210)	989 (382)	994 (480)	1004 (486)

Note. AST = affective Simon task, AN = anorexia nervosa, HC = high caloric, LC = low caloric.

main effect of stimulus type, $F(1, 118) = 6.74$, $p = .01$, $\eta^2_p = .54$, which was qualified by a stimulus type × group interaction, $F(1, 118) = 6.92$, $p = .01$, $\eta^2_p = .06$, indicating that the effect of stimulus type differed across groups (see Figure 1A). The effect remained stable when corrected for hunger, $F(1, 117) = 3.76$, $p = .05$, $\eta^2_p = .03$. There was no main effect of group, $F(1, 118) = 0.36$, $p = .64$, $\eta^2_p < .01$. To further interpret the interaction, follow-up *t*-tests were conducted. Independent samples *t*-tests showed that there was no significant difference between patients and controls for low caloric food, $t(118) = 0.89$, $p = .35$, $d = .16$, whereas there was a borderline significant effect for high caloric food, $t(118) = 1.92$, *p*

= .06, d = .37. Automatic approach tendencies towards high caloric food tended to be reduced in AN spectrum patients compared to healthy controls. In addition, paired samples t- tests showed that AN spectrum patients, showed stronger approach bias towards low caloric food than towards high caloric food, $t(62) = 3.39$, $p < .01$, $d = .86$, whereas there were no such differences for the control group, $t(56) = 0.03$, $p = .98$, $d < .01$. Finally, one sample t-tests were conducted to determine whether the bias scores differed from zero. For the control group there was no significant approach or avoidance bias in errors (no difference from zero), for neither high, $t(56) = 0.71$, $p = .48$, $d = .19$ nor low caloric food, $t(56) = 0.64$, $p = .53$, $d = .17$. However, for the AN spectrum patients the AST-index tended to be lower than zero for high caloric food, $t(62) = -1.86$, $p = .07$, $d = .30$, and higher than zero for the low caloric food $t(62) = 2.07$, $p = .04$, $d = .53$. Thus AN spectrum patients tended to show avoidance of high caloric food and approach towards low caloric food.

Response latencies. The same analyses were conducted for approach bias based on response latencies, and although the pattern of the interaction was in the same direction as in the error analysis, none of the effects in the ANOVA reached significance, all Fs (1, 108) < 2.04, all ps > .16, all $\eta^2_p < .02$ (see Figure 1C).

Independent predictive value of the AST and SRC

There was a significant relationship between the SRC and AST high caloric bias scores for both response latencies and error rates (see Table 4). To test to what extent SRC and AST high caloric indices were independently related to the presence of AN, a backward logistic regression analyses was done. Tests to see if the data met the assumption of collinearity indicated that multicollinearity was not a problem, SRC errors VIF = 1.12, response latencies VIF = 1.12, AST errors VIF = 1.18 and response latencies VIF = 1.19. In the regression analysis, only the SRC response latencies index remained as a significant predictor in the final equation, $\chi2$ (1) = 5.55, p = .02, indicating that only the SRC response latencies index had a unique relationship with the presence of AN, B = -.001, SE .001, p =.04.

Table 4. *Correlations between SRC and AST HC indices and group (AN / control)*

	Group	SRC errors	SRC RL	AST errors
Group				
SRC errors	-.10			
SRC RL	-.21*	-.05		
AST errors	-.15	.29**	.15	
AST RL	-.15	.16	.29**	.29**

Note. AN = anorexia nervosa, AST = affective Simon task, SRC = stimulus response compatibility task, HC = high caloric, RL = response latencies, * = p <.05, ** p = <.01.

DISCUSSION

The aim of the current study was to test whether AN-patients have reduced automatic approach tendencies towards food, and to examine whether this effect would be evident both in a paradigm in which food was relevant for correct task performance (SRC), as well as in a paradigm in which food was task-irrelevant (AST). In short, the overall pattern of results was very similar for both types of tasks and consistent with the hypotheses. In the SRC (response latencies), AN spectrum patients failed to show the automatic approach for high caloric food that was evident in the healthy controls. In the AST (error percentage), specifically AN spectrum patients showed avoidance tendencies for high caloric food. Only the SRC response latencies index showed an independent relationship with the presence of AN. The findings are consistent with neurocircuit research in AN indicating that patients with acute AN show amygdala and insula activation that may represent avoidance motivation for food (Friederich, Wu, Simon, & Herzog, 2013; Kaye et al., 2009).

Reduced automatic approach tendencies for food in AN

The current performance-based measures revealed that AN spectrum patients showed reduced automatic approach tendencies towards food compared to healthy controls. These findings are consistent with earlier studies using indirect performance-based measures to examine more automatic responses toward food in AN (Paslakis et al., 2016; Roefs et al., 2005; Veenstra & de Jong, 2011). These outcomes might help explain why AN patients, in contrast to unsuccessful dieters and people with obesity, manage to succeed in complying with their deliberate intention to restrain from food even in situations where others often fail (e.g., stress, feelings of hunger). Perhaps as a result of prolonged starvation and repeated exposure to food without eating, food might have lost its incentive value in AN patients (Pinel, Assanand, & Lehman, 2000). Therefore, individuals with AN may be relatively effective in ignoring the seductive properties of food items.

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Task-relevant vs. task-irrelevant context

The results of both computerized performance-based measures indicate that AN spectrum patients show less automatic approach tendencies than healthy controls in two different types of situations. The SRC was included as an analogue for common meal time situations, whereas the AST was included as an analogue for situations outside a common meal (e.g., while working behind one's desk). This is the first study showing reduced automatic approach towards food in situations where food is task-relevant (SRC), indicating that AN spectrum patients are better in not approaching food than healthy controls when explicitly instructed to do so and when food items cannot be ignored.

Moreover, the AST results confirm that automatic approach tendencies in AN are also weakened in situations where food is irrelevant for one's current tasks (Paslakis et al., 2016; Veenstra & de Jong, 2011), possibly indicating a decreased sensitivity to the seductive properties of food when involved in tasks not related to food. Both types of reduced automatic approach tendencies towards high caloric food may facilitate the goal to restrict food intake across different kinds of situations. Given the quite small correlation between the AST and the SRC, the present data might be considered as consistent with the starting point that both computer tasks measure different, but related, constructs, and that the distinction between food as a task-relevant versus task-irrelevant feature seems to matter. Only the SRC uniquely predicted the presence of AN. Thus, although in both conditions AN spectrum patients showed less approach, the current findings indicate that reduced approach when food is task-relevant, is most critical in AN.

Interestingly, for the AST, the between group difference was most pronounced in the error analysis, whereas for the SRC the difference was most pronounced when indexed by response latencies. One explanation for this finding might be that the task to approach or avoid food pictures (SRC) is easier than the task to approach or avoid top /side view pictures (AST). Indeed, it seems that overall fewer errors were made during the SRC than during the AST (see Table 2). This may have rendered the SRC less sensitive for finding differential effects in terms of error rates, but more sensitive for finding differential effects in terms of response latencies, whereas the opposite would yield for the AST. Consistent with the view that the AST would be relatively sensitive for finding differential effects in terms of error rates, it is more often reported that AST-effects were only evident as indexed by error rates (Vervoort et al., 2010). Furthermore, it was found that the SRC was more sensitive in finding group differences using response latencies (Field, Caren, Fernie, & De Houwer, 2011).

Although the differential AST-effect was only significant for the error-analysis, and the differential SRC-effect only for the reaction time analysis, the overall pattern of findings was very similar for both tasks and for both dependent variables, so no speed accuracy tradeoff seems present (see also Figure 1). For both tasks, the pattern of error indices suggests that AN spectrum patients show a tendency to avoid high caloric food, whereas controls do not show a bias towards or away from food. For both tasks, the pattern of response latency-indices suggests that AN spectrum patients do not show a bias, whereas controls show an approach bias. The lack of interference effects (influence of the content of the picture) in terms of differential response latencies for AN spectrum patients suggest that in both contexts AN spectrum patients seem very well able to deal with the distracting properties of the food stimuli and to just focus on the task demands. However, on some trials they fail and their automatic reaction to avoid food then leads to an error. Consequently, more errors are made on approach food trials than on avoid food trials compared to neutral approach and avoidance trials. The interference effect in terms of differential response latencies for the controls seems to indicate that they did (or could) not fully ignore the distracting properties of the food stimuli. Their pattern of response latencies suggests that it required cognitive effort to control their automatic (approach) responses, yet, apparently within the current task-context their cognitive control was sufficient to prevent the occurrence of actual erroneous responses.

Future research

A next question is whether automatic approach tendencies are subject to change (i.e., becoming more similar to the pattern of healthy controls) following successful treatment, or remain different from healthy controls and might then consequently be a risk factor for relapse. So far, only one study has explored the pattern of automatic approach/avoidance tendencies in the context of treatment.

This study showed that one year after the start of treatment, automatic approach tendencies for high caloric food measured with an AST-manikin, increased to the level for low caloric food (Neimeijer, de Jong, & Roefs, 2015). The pattern of approach bias during follow up looked similar to the pattern found in healthy controls which suggests that overall automatic approach towards food recovered back to normal after one year. However, this was not directly associated with actual improvement in terms of reduced eating disorders symptoms (EDE scores and underweight), nor were baseline levels predictive for the eating disorder symptoms at one year follow up.

An explanation might be that in general there is much room for improvement of eating disorder symptoms and many patients still received treatment at one-year follow up. Consequently, more time might be needed to find a direct association between automatic approach tendencies towards food and (improvement of) eating disorder symptoms. Furthermore, in this previous study only the AST was administered, whereas it might be that automatic approach tendencies during a regular meal (modelled by the SRC) are more important for recovery. This idea is supported by the finding that specifically the SRC is related to AN. It would be helpful doing further longitudinal research on this topic also with a task-relevant measure to gain more insight in the presence/absence of automatic approach tendencies in the context of AN and to test whether specifically change in the SRC index is associated with reduction of eating disorder symptoms.

To determine whether the absence of automatic approach is a causal factor in maintaining eating disorder symptoms, an important next step would be to directly manipulate it. A prior study using a cognitive modification procedure that trained participants to move a manikin towards or away from chocolate, had the predicted effect on approach bias: participants trained to approach chocolate demonstrated an increased approach bias to chocolate stimuli whereas participants trained to avoid such stimuli showed a reduced bias (Schumacher, Kemps, & Tiggemann, 2016). Further, participants trained to avoid chocolate ate significantly less of a chocolate muffin in a subsequent taste test than participants trained to approach chocolate . Thus, modifying automatic approach tendencies can not only have an influence on the tendencies itself, but also on actual behaviour. Perhaps treating both explicit processes (e.g., cognitive therapy) as well as automatic processes (e.g., enhancing the automatic tendency to approach food) eventually can lead to a more persistent modification of AN-patients' inclination to restrict their food-intake.

Limitations

One limitation of the current study concerns the balanced order of the performance measures, to control for carry-over effects. It cannot be ruled out that the carry-over effect of the SRC on the AST was more pronounced than vice versa. Furthermore, we did not include low caloric food pictures in the SRC to keep the number of pictures that had to be approached and avoided within one block equal. It could however be that the absence/ presence of low caloric food has influenced the automatic response towards high caloric food.

Conclusions

To conclude, in the current study we examined the relevance of reduced automatic approach tendencies toward food in AN spectrum patients. We differentiated between automatic approach tendencies when food was task-relevant (as a model of a common meal situation) and when food was task-irrelevant (as a model of being seduced by task-irrelevant food stimuli). Individuals with AN showed a reduced automatic approach tendency toward high caloric foods, both when food was task-relevant and when food was task-irrelevant. Yet, especially the reduced approach tendency when food was task-relevant and could not be ignored (as a model of a regular meal context) seemed the most critical characteristic of patients with AN. These reduced automatic approach tendencies might 'help' patients with AN to restrict their food-intake even in a condition of starvation.

Appendix A

Example of an AST-manikin trial

Chapter 6

Automatic Approach/Avoidance Tendencies Towards Food and the Course of Anorexia Nervosa.

This chapter is based on: Neimeijer, R. A. M., de Jong, P. J., & Roefs, A. (2015). Automatic Approach/Avoidance Tendencies Towards Food and the Course of Anorexia Nervosa. Appetite, 91, 28-34.

ABSTRACT

The aim of the present study was to investigate the role of automatic approach/avoidance tendencies for food in anorexia nervosa (AN). We used a longitudinal approach and tested whether a reduction in eating disorder symptoms is associated with enhanced approach tendencies toward food and whether approach tendencies toward food at baseline are predictive for treatment outcome after one year follow up.

The Affective Simon Task-manikin version (AST-manikin) was administered to measure automatic approach/avoidance tendencies towards high-caloric and low-caloric food in young AN patients. Percentage underweight and eating disorder symptoms as indexed by the EDE-Q were determined both during baseline and at one year follow up.

At baseline anorexia patients showed an approach tendency for low caloric food, but not for high caloric food, whereas at 1 year follow up, they have an approach tendency for both high and low caloric food. Change in approach bias was neither associated with change in underweight nor with change in eating disorder symptoms. Strength of approach/avoidance tendencies was not predictive for percentage underweight.

Although approach tendencies increased after one year, approach tendencies were neither associated with concurrent change in eating disorder symptoms nor predictive for treatment success as indexed by EDE-Q. This implicates that, so far, there is no reason to add a method designed to directly target approach/avoidance tendencies to the conventional approach to treat patients with a method designed to influence the more deliberate processes in AN.

INTRODUCTION

Anorexia nervosa (AN) is characterized by extreme concerns of gaining weight despite existing underweight. Effectiveness of leading treatments for adolescents with AN such as Family Based Therapy (FBT) and Cognitive Behavioural Therapy (CBT) is however limited and relapse rates after recovery are high(see Byrne, Fursland, Allen, & Watson, 2011; Hay, 2013; Lock et al., 2010). A key question is how to explain these limited success rates. One possible explanation for the relatively limited efficacy of those treatments might be their primary focus on conscious appraisals as the starting point of the interventions. Both CBT and FBT aim to target 'explicit' processes, by replacing dysfunctional thoughts with more effective thoughts, thus decreasing emotional distress and self-defeating behaviour. However, dual process models emphasize that next to these more explicit, deliberate processes, also more automatic, implicit, processes exists (Gawronski & Bodenhausen, 2006). Dual process models imply that behaviour is the consequence of an interplay between the reflective and the more implicit, automatic processes. In the reflective system, behaviour is guided by deliberate decision-making processes. Executive functions are needed to plan behaviour, to weigh possible consequences, and to consequently behave in an intended goal-directed manner. In the implicit (or reflexive) system, behaviour is directly activated by associative clusters in memory and this occur spontaneously and outside of people's awareness or control. These associative clusters are formed in long-term memory through repeated experience. No executive functions or cognitive effort are needed for activating behaviour, and therefore it is assumed that this system is predictive for behaviour in situations where less cognitive resources are available (e.g., time pressure, cognitive depletion, or stress) (Strack & Deutch, 2004). Moreover, implicit cognitions are assumed to be critically involved in habit-like, repetitive behaviours (e.g., Strack & Deutsch, 2004; Walsh, 2013) which are typical for AN (e.g., rigid dieting).

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Clearly, one could argue that the refusal to eat in AN is a more deliberate process. Consequently, conventional treatment is used to address problematic behaviour in a top-down manner by taking the reflective system as the starting point. However, also bottom-up processes might play a role in AN. Several studies provided evidence that implicit, automatic processes may be involved in (un)uccessful dieting (Roefs et al., 2011). Accordingly, studies on attentional bias show that eating disorder patients, particular those with BN, have an attention bias for food. While in AN evidence is mixed, in BN food stimuli might elicit greater incentive saliency, prompting the desire to eat food (Brooks, Prince, Stahl, Campbell, & Treasure, 2011). An attentional bias for food might therefore lead to increased intake (Werthmann et al., 2015). In addition, non-successful dieters have been found to show enhanced automatic approach tendencies towards pictorial food items (Veenstra & de Jong, 2010). Although evidence is mixed and also some research point in the opposite direction (e.g., Fishbach & Shah, 2006), the view that automatic processes influence actual intake, is further supported by a study that showed that implicit measures were predictive for food intake in case of low cognitive resources (Friese, Hofmann, & Wänke, 2008). Also in other areas of psychopathology a relation was found between intake and approach tendencies for the relevant substance, as for instance in alcohol(e.g., Field, Kiernan, Eastwood, & Child, 2008). Moreover, analogue studies have shown that experimentally reducing automatic chocolate-approach tendencies, also reduced participants' craving for chocolates (Kemps, Tiggemann, Martin, & Elliott, 2013).

Whereas in disinhibited eating and addiction heightened automatic approach tendencies may be involved, in AN, the opposite might be the crucial problem. The common approach tendencies for food might be absent in individuals with AN. In this way, AN patients are more similar to individuals with anxiety disorders, in that they too show an avoidance tendency away from disorder-relevant (threatening) stimuli (e.g., Rinck & Becker, 2007). Avoidance of high caloric food can become a well-established habit and very resistant to change (Walsh, 2013). The successful restriction of food intake in AN patients, even under conditions that typically impair self-control might then thus be explained by assuming that automatic responses toward food are weakened or perhaps absent among AN patients. In line with such a view, recent research using an indirect approach avoidance task, provided evidence indicating that indeed the common approach bias towards high caloric food was attenuated in AN patients compared to non-symptomatic controls (Veenstra & de Jong, 2011).

Possibly conventional treatment has a limited effect on this type of more automatic processes. It could therefore be hypothesized that treatment success is limited if these relevant automatic processes remain unaffected. In other words, limited treatment success in AN patients might be associated with a failure to enhance automatic approach tendencies towards food items. As a first step to examine whether the efficacy of the treatment of AN indeed critically depends on its success in normalizing the approach tendencies toward food, the present study tested whether approach/avoidance tendencies change over time, and examined whether the reduction in AN symptoms was associated with an increase in approach tendencies toward food. Moreover, if a lack of approach tendencies toward food indeed plays an important role in the persistence of eating disorder symptoms, relatively weak approach tendencies at baseline might be an important moderator of treatment success. Therefore, the next aim of the study was to test whether (low) approach tendencies toward food at baseline predicted (worse) treatment outcome at one-year follow up. The current study used a longitudinal design, in which approach tendencies for food and eating pathology of a large group of AN patients were measured at the moment of intake and at a fixed subsequent assessment at one-year follow up. In short, the major aim of the current study was to test whether (i) approach tendencies changes between moment of intake and one year follow-up, (ii) a reduction in eating disorder symptoms is associated with enhanced approach tendencies toward food, and (iii) approach tendencies toward food at baseline are predictive for treatment outcome after one year follow up.

METHOD

Participants

Participants were 152 adolescents (*M* age = 14.97, *SD* = 1.63, range 10-20) who were admitted between 2007 and 2012 for treatment at the Department of Eating Disorders of Accare in Smilde, and who fulfilled the DSM-IV criteria for AN (*n* =87), or EDNOS with characteristics of AN, as diagnosed by the child version of the Eating Disorder Examination (EDE) interview (EDE; Bryant-Waugh, Cooper, Taylor, & Lask, 1996). The content of the child EDE is very similar to the adult EDE interview. We used the child version for all participants because we preferred one diagnostic instrument for the whole group, and to reassure also younger patients would understand the questions. The EDNOS-group consisted of patients who met most, but not all, criteria of AN. More specifically, this group consisted of patients who had menses (*n* = 11), were underweight but less than 15% (*n* = 20), were nonfat phobic AN (n = 26), or had partial AN (i.e., missing two of the four criteria) (*n =7*) (cf. Thomas, Vartanian, & Brownell, 2009).

Materials

Affective Simon Task Manikin Version (AST-manikin)

Overview. As an index of automatic approach/avoidance tendencies for food, a manikin task with food pictures was used that was based on the pictorial AST originally developed by de Houwer (2001), and previously used in the context of eating disorder symptoms and has shown construct validity in the context of eating disorders (Veenstra & de Jong, 2011) as well as in other kinds of psychopathology (e.g., Wiers, Rinck, Kordts, Houben, & Strack, 2010). In order to measure the automatic reaction towards food, in a way that is relatively insensitive to strategic influences, the content of the stimuli (high-caloric food, low-caloric food, or neutral pictures) was a task-irrelevant stimulus feature. The required response (move toward or away) was defined by the perspective of the picture: top-view or side-view. So, perspective of the picture was task-relevant for the participants and the content of the picture (i.e., food or neutral) could thus be ignored. Assignment of the required response (move toward or move away) to the task-relevant feature (top-view/side-view) was counterbalanced over participants. The task was programmed in E-prime 1.1 (Schneider, Eschman, & Zuccolotto, 2002) and was run on a Windows XP computer with a 22 inch CRT monitor (resolution set to 1024 by 768 pixels).

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Stimuli. The selection of stimuli was based on a study on the evaluation of high- and low-fat food (Roefs, Herman, MacLeod, Smulders, & Jansen, 2005) and has previously been used in studies on automatic approach tendencies in restrained eaters (Veenstra & de Jong, 2010) and AN patients (Veenstra & de Jong, 2011). Pictures are used because food pictures activate the same neural regions as tasting the actual food (Simmons, Martin, & Barsalou, 2005). Concrete, the stimuli consisted of eight high-caloric food pictures (pizza, croissant, chocolate, crisps, chips, ice-cream, brown spiced biscuit, and toast with ham and cheese), eight low-caloric food pictures (strawberries, melon, grapes, popcorn, carrots, cherries, pineapple, and chicken). Five neutral stimuli were pictures of bowls and mugs. Of every stimulus, two different pictures (380 x 285 pixels) were constructed: one top-view and one side-view picture.

Trial specification. Each trial started with a 1000 ms presentation of a fixation dot. Next, a picture appeared in the middle of the screen, and a black manikin appeared above or below the picture.

Participants had to move the manikin as quickly as possible, depending on instruction, toward or away from the picture by pressing the arrow buttons until the manikin reached the picture (approach) or the edge of the screen (avoid). During the entire task, the instruction to approach either top view or side view was the same to avoid interference effects of different instructions. In case of a correct response, the next trial started automatically. In case of an incorrect response, the next trial appeared only after the erroneous response was corrected. The task consisted of a practice block of eight trials, followed by two test blocks of 84 trials each. Trials differed in stimulus type (high caloric, low caloric, or neutral), the side from which the photograph was taken (top-view or side-view), and position of the manikin (i.e., above or below the picture). Every combination was presented equally often. Each stimulus was presented four times in each block. Trials were presented in an individually randomized order.

Eating Disorder Examination Questionnaire

The child version of the Eating Disorder Examination Questionnaire (EDE-Q, Fairburn & Bèglin, 1994) was administered, as a measure for severity of eating disorder symptoms. The EDE-Q is the questionnaire version of the Eating Disorder Examination and consists of four subscales (0 – 6 points): restraint, eating concern, weight concern, and shape concern. The total EDE-Q score provides a global measure of the severity of eating disorder pathology. Examples of questions are: "Have you had a strong desire to lose weight?" and "Has thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example working, following a conversation, reading)?", answered on a scale between 0 (no days and 6 (every day). Psychometric evaluation indicates that the four subscales of the EDE-Q have excellent internal consistency and test–retest reliability (Luce & Crowther, 1999). Also in the current sample the EDE-Q showed a high internal consistency (23 items, α = .93). Previous normative research with adult samples (>18 years) reported a mean score of 4.1 in a large group of AN patients(Brewin, Baggott, Dugard, & Arcelus, 2014).

Craving, liking, and frequency

As explicit proxies of approach tendencies we assessed participants' craving for and liking of all food stimuli, as well as participants' frequency with which they ate the food items represented on the pictures that were used in the implicit task. To index craving we asked: "How much do you crave this product at this moment?" Liking of food items of the AST was assessed by answering the question: "How much do you like this product?". To assess the frequency with which they ate the particular food we asked "How frequently do you eat this product". The questions were answered on a VAS ranging from 0 (not at all) to 100 (very much).

Procedure

Within four weeks after intake, participants carried out the AST-manikin task. Self-report measures (VAS, EDE-Q) were administered following completion of the computer task. Finally, weight and height data of all participants were collected.

After intake, they received treatment as usual in a specialised clinic for treating eating disorders.

This consisted of cognitive behavioural (group/individual) therapy varying in length, both inpatient and outpatient. Since treatment varied in time and lengthy treatment is not uncommon, a design with a fixed subsequent assessment at one-year follow up was chosen. After one year, independent of treatment status, patients were asked to participate in the follow-up assessment. Firstly, the EDE-interview was administered to verify the current diagnosis. After that, the AST-manikin and self-report measures were completed.

Data reduction

For the error-analysis of the AST-manikin, trials of which the first response was in the wrong direction were identified as errors. For the initiation time analysis, trials with errors and trials with response latencies below 200 ms and above 2000 ms were excluded from analyses.

AST-effect scores were computed by subtracting error percentages and response latencies of approach trials from corresponding avoidance trials (cf. Rinck & Becker, 2007). Positive AST-effects are indicative of an automatic tendency to approach rather than to avoid pictures, and negative AST-effects reflect a tendency to avoid rather than to approach pictures. Subsequently, approach bias was calculated by subtracting AST-effects of neutral pictures from AST-effect for high and low caloric food items hereby controlling for non-specific differences in approach and avoidance tendencies. Higher scores on approach bias refer to a tendency to approach high or low caloric food compared to neutral pictures, whereas lower scores refer to a tendency to avoid food.

Percentage underweight was derived from the 50^{th} percentile of height and age. Change in approach tendencies was calculated by subtracting approach bias index at T1 from the index at T2 for both high and low caloric food. Positive scores refer to a positive change in approach tendencies (i.e., enhanced approach tendencies towards food). Change in percentage underweight and change in eating disorder symptoms was calculated by subtracting T2 scores from T1 for both percentage underweight and eating disorder symptoms. Positive scores refer to less underweight/fewer eating disorder symptoms.

RESULTS

Group Characteristics

Approximately half of the participants who were assessed at baseline also completed the assessment at 1 year follow up (n = 76). There were various reasons for dropping out: living too far away from the treatment centre, doing well and not wanting to be reminded, doing poorly and not feeling able to participate, and just not wanting to participate. After one year, of the 76 participants, 23 patients still met the criteria of AN or EDNOS with specific characteristics of AN. Of 5 patients the diagnosis was bulimia nervosa, or EDNOS (but not the 'AN-like' subtype). 48 patients did not have a *DSM-IV* eating disorder anymore.

To test whether patients who remained in the study differed from patients who dropped out, we compared both groups at baseline by means of independent sample t-tests. Outcome of these comparisons indicated that at baseline drop-outs and completers did not differ on age, educational level, percentage underweight, scores on the EDE-Q, and AST-error or AST-RT at the time they were admitted to treatment (i.e., T1). Missing data at follow up were estimated using multiple imputation, which is one of the preferred methods for dealing with (a high level of) missing data (Schafer & Graham, 2002). Missing data were imputed 40 times with predictive mean matching, with the following predictors: percentage underweight, EDE-Q, AST response latencies and errors, VAS-scores, as well as other variables outside the present study (depressive symptoms, eating disorder symptoms, body image, and self-perception) to impute as accurately as possible. Unless otherwise specified, results of the multiple imputed dataset are displayed. We report the pooled results. Overall, percentage underweight and eating disorder psychopathology were significantly decreased at one-year follow-up, see Table 1.

Table 1. *Group characteristics*

	Baseline		Follow up		Between group tests	
	M	*SD*	*M*	*SD*	*t*	*p*
Percentage underweight	21.37	7.63	9.50	7.29	11.90	<.001
EDE-Q – restraint	3.39	1.69	1.74	1.34	8.16	<.001
EDE-Q – eating concerns	2.98	1.14	1.72	1.27	7.68	<.001
EDE-Q – weight concerns	3.84	1.39	2.43	1.53	7.60	<.001
EDE-Q – shape concerns	4.26	1.41	2.84	1.68	7.33	<.001
EDE-Q – total score	3.62	1.20	2.17	1.38	9.22	<.001

Note. EDE-Q = Eating disorder examination, child version

Do automatic approach/avoidance tendencies change from baseline to follow up?

Approach bias with error rates and response latencies were analysed using a 2 (stimulus type: high vs low caloric food) × 2 (time: T1, T2) repeated measures analysis. In the error analysis, there was a significant effect of stimulus type, $F(1, 151) = 6.78$, $p = .01$. Participants showed stronger approach bias toward low caloric compared to high caloric food. There was no main effect of time, $F(1, 151) = 1.36$, $p = .25$, indicating that there was no overall difference between approach bias at T2 compared to T1. There was however a borderline significant stimulus type ×time interaction, $F(1, 151) = 3.6$, $p = .06$, suggesting that the effect of stimulus type differed between T1 and T2. Subsequent analyses revealed that the approach bias for HC food at T1 was significantly lower than for LC food, $t(1894) = 2.48$, $p = .01$, whereas such difference was absent at T2, $t(225) = 0.36$, $p = .72$. In addition, there was a nonsignificant trend that approach bias for high caloric food tended to be stronger at T2 than at T1, $t(999) = 1.41$, $p = .16$, whereas the approach bias for low caloric food remained virtually identical, $t(403) = 0.14$, $p = .89$ (see Figure 1). To facilitate the interpretation of the current pattern of results, it was subsequently examined whether approach bias for high and low caloric food differed from zero (i.e., whether the approach/ avoidance tendencies for high and low caloric food were different from neutral pictures). At T1 approach bias differed from zero only for low caloric food, $t(152) = 1.55$,

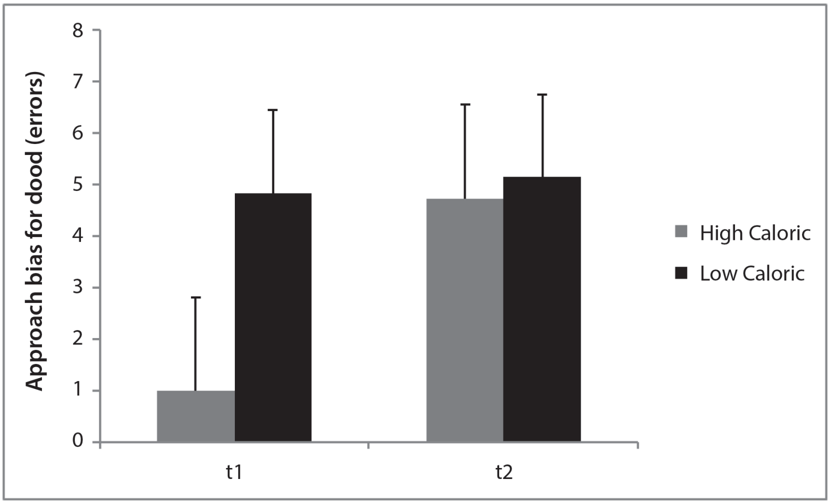

Figure 1. *Approach bias for high and low caloric food. Higher values indicate stronger approach tendencies. Error bars represent standard errors of the mean.*

Table 2. *AST-Manikin: Percentage Errors and Initiation Times As A Function of Time and Stimulus Type*

	Baseline			Follow up		
	HC	LC	NEU	HC	LC	NEU
Errors						
Approach	18.59 (13.38)	14.90 (9.91)	20.50 (11.96)	13.51 (7.13)	13.02 (6.55)	18.26 (10.83)
Avoidance	30.26 (15.56)	30.41 (16.57)	31.17 (19.50)	25.86 (12.49)	25.83 (12.88)	25.93 (14.07)
AST-effect	11.66 (18.27)	15.51 (15.36)	10.67 (20.67)	12.34 (12.59)	12.81 (12.51)	7.67 (16.43)
RT						
Approach	803 (239)	773 (186)	811 (192)	748 (130)	724 (118)	757 (121)
Avoidance	913 (208)	889 (197)	898 (212)	848 (131)	833 (106)	826 (129)
AST-effect	109 (181)	116 (127)	88 (150)	100 (86)	109 (76)	68 (78)

Note. Mean characteristics, with *SD* in parentheses; HC = high caloric food; LC = low caloric food; NEU = neutral. Response latencies in MS.

p <.001, whereas at T2, approach bias for both high and low caloric food differed from zero, $t(152)$, = 1.55, $p < .001$, and $t(152) = 1.64$, $p < .001$, respectively.

In the response latency analysis, there was neither a significant main effect of stimulus, $F(1, 151) = 1.26$, $p = .26$, nor an effect of time, $F(1, 151) = 0.72$, $p = .40$. Also the interaction effect did not approach significance $F(1, 151) = 0.5$, $p = .48$.

Since a large group still met criteria for an eating disorder at T2, an additional completers error analysis was done with diagnostic status at time 2 (recovered vs. non recovered) as between subjects variable and time and stimulus type as within subject variable. No group effect was found, neither the relevant time × group interaction was significant, $F(1, 68) = .97$, $p = .33$ and $F(1, 68) = 1.57$, $p = .22$ respectively.

Is there a relation between change in automatic approach tendencies and change in eating disorder symptoms?

There was no relation between change in approach bias (AST-error/ AST-RT) and change in percentage underweight, nor between change in approach bias and change in eating disorder symptoms. The pattern was similar for high and low caloric food items, all *r*s between -.11 and .09, all *p*s > .25.

Do automatic approach tendencies at baseline have predictive value for eating disorder symptoms at one year follow up?

To determine the predictive effect of approach tendencies, the correlations between approach bias at T1 and eating disorders symptoms/ percentage underweight at T2 were calculated. There was neither a significant correlation for high caloric food, nor for low caloric food. This was the case for error and response latency analyses, all *r*s between -.05 and -.12, all *p*s >.31

Self-report measures: VASs

Craving, liking, and frequency of eating both high and low caloric food increased significantly after one year (see Table 3). No significant correlations were found between approach bias for high and low caloric food and the self-report measures, all *r* between -.15 and .12, all $p > .12$. Frequency of eating high caloric food at T1 was correlated with EDE-Q score at T1, $r(152) = -.208$, $p = .02$. Craving, liking, and frequency of eating high caloric food at T2 was associated with EDE-Q-scores at T2, $r(152) = -.236$, $p = < .01$; $r(152) = -.213$, $p = .01$; $r(152) = -.367$, $p < .001$. There was no significant correlation between craving and liking and EDE scores at T1, $r(152) = -0.85$, $p = .33$, $r(152) = -.145$, $p = .09$, neither between change in craving and liking for high caloric food and change in EDE-Q scores, $r(152) = .109$, $p = .26$ and $r(152) = .110$, $p = .28$. Yet, there was a significant relationship between the change in frequency and change in EDE-Q, $r(152) = .234$, $p =.01$.

Table 3. *craving, liking and frequency of high and low caloric food*

	Baseline		Follow up		Between group tests	
	M	*SD*	*M*	*SD*	*t*	*p*
HC						
Liking	58.12	26.84	64.25	17.06	2.71	<.01
Craving	24.16	26.42	36.65	21.58	5.25	<.001
frequency	18.33	15.15	29.81	16.35	7.63	<.001
LC						
Liking	64.30	18.56	69.89	12.37	2.71	<.001
Craving	31.20	23.76	45.73	17.30	6.91	<.001
frequency	36.27	16.71	46.45	10.81	3.96	<.001

Note HC = high caloric; LC = low caloric.

DISCUSSION

The present study investigated the course of automatic approach tendencies in AN patients. The major results can be summarized as follows: (i) Error analysis of the AST showed that anorexia patients have an approach bias for low caloric food , but not for high caloric food, at baseline, whereas at 1 year follow-up, they have an approach bias for both high and low caloric food. (ii) Change in approach bias was neither associated with change in underweight nor with change in eating disorder symptoms, and (iii) Approach tendencies toward food at baseline were not predictive of percentage underweight at 1-year follow-up.

Relationship between change in automatic approach tendencies and change in eating disorder symptoms

The first aim of the study was to verify whether approach tendencies changed during treatment and whether this was related to indices of treatment success. In line with previous research, AN-patients showed no approach tendencies for high caloric food during the baseline assessment at the time they were admitted for treatment (Veenstra & de Jong, 2011). After one year, however, these approach tendencies increased to the level for low caloric food. The pattern of the follow up looks similar to the pattern found in healthy controls (Veenstra & de Jong, 2011), which suggests that overall approach tendencies towards food recover back to normal after one year. It is not uncommon to find pictorial AST-effects in errors (probably because task instruction focuses more on maximizing speed than accuracy see, e.g., Veenstra & de Jong, 2011).

Because the used approach index (subtracting errors on neutral cues from errors on both high and low caloric food) controls for nonspecific approach tendencies, it cannot be explained by higher approach tendencies in general. It is neither plausible that learning effects (reduced interference of food as a task-irrelevant feature) would have influenced the AST-effects at follow up, because the effects of food remained constant over time. In fact, if patients learned from T1 to ignore processing the task-irrelevant content of the stimuli (i.e., food itself), then AST-effects at T2 are an underestimation of the real approach tendencies toward food. Because there was no no-treatment control group, it should be acknowledged, however, that it cannot be ruled out that the found results reflect a spontaneous instead of a treatment-induced change.

The apparent recovery of approach tendencies for high caloric food was not directly associated with actual improvement of the eating disorders symptoms, as indicated by an absence of a significant correlation between change of approach tendencies and change in eating disorder symptoms. If either the implicit (AST) or the explicit measure (EDE-Q scores and percentage underweight) did not change sufficiently, this finding would be a logical consequence. However, both the explicit as well as the implicit measure improved so this provides no adequate explanation for the lack of an association. A power analysis was done, which ruled out the possibility that the study was underpowered. To reach a power of .70 with a medium effect size and an alpha of .05, 65 participants were needed.

It seems that improvement of approach tendencies towards food are not crucial for the course of

AN, and improvement in EDE scores can be attained without improvement of approach tendencies. Conversely, improvement on an implicit measure does not also imply recovery as indicated by self-report measures. This holds for at least the relatively short-term outcome, that is, one year after start of treatment. The absence of a straightforward relationship between improvement as indexed by body weight and eating disorder symptoms (EDE-Q) and improvement as indexed by increased approach tendencies towards food, may implicate that some patients have learned helpful cognitions but did not experience a change at the more implicit level. It is therefore possible that if approach tendencies remain at a low level, they have an influence on behaviour whenever food situations are encountered. Consequently, insufficiently increased approach tendencies would then heighten the risk of relapse. An important next step would thus be to find out whether patients in whom EDE-Q scores, but not approach tendencies toward food, changed in a favorable way, are at a relatively high risk for relapse. Germane to this, a recent study in the context of speech anxiety showed that the strength of residual negative automatic associations with speaking in public after successful treatment had predictive value for the return of fear (Vasey, Harbaugh, Buffington, Jones, & Fazio, 2012). In analogy, absence of automatic approach tendencies toward food might be associated with a higher chance of a return of eating disorder symptoms.

Although treatment did not focus directly on changing automatic processes, the findings support the possibility that treatment does have an effect on approach tendencies, since there was no approach bias for high caloric food at T1, whereas there was at T2. The suggestion that treatments that focus on the more deliberate processes can be in itself also responsible for changing automatic processes, is in line with the idea that automatic processes may develop through the acquisition of new information that changes higher order beliefs, which in turn modify functionally-related lower order automatic processes (Mansell, 2000). Accordingly, although automatic processes can operate without conscious control, voluntary processes can be responsible for changes in automatic processes. However, no final conclusions can be drawn at this point since it was ethically unacceptable to include a waitlist/no treatment control condition in this group of under aged patients with a severe psychiatric disorder.

Even though results suggest that change in approach tendencies is not crucial for (short-term) treatment success, it could well be that patients could benefit from an intervention that aims to directly influence individual's approach/avoidance tendencies. Supporting the view that these approach tendencies can have a causal influence on actual behaviour, a training study of approach bias toward alcohol in problem drinkers revealed that a trained decrease in automatic approach tendencies toward alcohol was associated with lower alcohol consumption (Wiers et al., 2010). Perhaps, then, AN patients could benefit from a training designed to increase (instead of to decrease) approach tendencies toward food items.

The predictive value of automatic approach tendencies for eating disorder symptoms at follow up

The next aim of the study was to determine the predictive value of approach tendencies for food on future eating disorder symptoms. Results indicated that approach tendencies at baseline were not predictive of the AN eating disorder symptoms at one year follow up. This finding supports the conventional approach to treat patients with a method designed to influence the more deliberate processes in AN. Based on the outcomes of this study, there is no direct reason to add a method to the treatment that directly targets the automatic approach/avoidance tendencies. However, it might still be that specifically for the group of AN patients with lowered approach tendencies for food at intake, it requires additional interventions such as automatic approach training to reach a sustained drop in symptoms at longer-term follow up. More research is needed to test this alternative hypothesis.

The finding that the approach tendencies are not predictive for eating disorder symptoms at 1 year follow up is not in line with the hypothesis that approach bias plays a crucial role in the maintenance of eating disorder symptoms. A possible explanation for this finding might be that initially treatment focusses especially at weight restoration. In line with this, after one year frequency of eating the food items was increased. Frequency of eating food was correlated with reduction of eating disorder symptoms as indexed with the EDE-Q. However, weight is not a perfect indicator of eating disorder severity after one year. One could have a BMI that fits in the normal range, but still have distorted cognitions and low approach tendencies and, therefore, still be at high risk for relapse. Even though patients improved significantly on EDE scores, compared with adolescents with no history of an eating disorder, the scores at follow up were still high, (i.e., 1 - 2 sd above mean: Watkins, Frampton, Lask, & Bryant-Waugh, 2005). This might imply that the improvement, though statistically significant, was not yet sufficient from a clinical perspective. In line with this, a study on wanting and liking in AN patients showed that weight-restored, but not fully recovered patients showed less implicit wanting for high caloric food compared to healthy controls (Cowdrey, Finlayson, & Park, 2013).

The outcomes of the longitudinal analyses should be interpreted with care, since the present study suffered from a substantial amount of drop-out. However, we multiple imputed the missing data and completers did not differ at intake from patients who dropped out. Furthermore, there was no difference in completers analysis and analysis with imputed data. High drop-out rates are not uncommon in large clinical samples, especially not in disorders accompanying with severe physical health problems. This study provides still unique insight in cognitive processes in a large clinical sample. To gain more insight in how approach tendencies develop over time, it is crucial to have a follow up longer than one year. Many patients still met criteria for an eating disorder after one year follow up and received treatment within the one-year interval. A one year follow up was chosen instead of a pre post treatment design, thereby controlling for time. However, a limitation of this design is that after one year follow up, the treatment status varied. Approximately half the sample still met criteria for an eating disorder. However, results showed that there was no difference in approach bias between patients who were recovered and patients who still met criteria for AN. Although not meeting *DSM-IV* criteria for AN or Eating Disorder not otherwise specified (with specific characteristics of AN) anymore, they still showed high EDE-Q scores, comparable with the patient group. This strengthens the idea that a longer follow up period is needed.

Implicit and explicit measures

Although behavioural approach tendencies and the self-report proxies (craving, liking, and frequency of eating high and low caloric food-items) both seem to increase after one year follow up, there was no significant correlation between the more implicit and explicit measures. This in line with previous research (e.g., Bosson et al., 2000; Veenstra & de Jong, 2011) and one interpretation is that both types of measures assess different components of people's motivational orientation towards food. The implicit measures may more closely reflect the more automatic processes whereas the explicit measures may more closely reflect the more deliberate processing of food. Alternatively, response bias that would only affect explicit measures but not implicit measures may also explain the lack of correlation (Roefs et al., 2011). Importantly, only the change in the (explicitly reported) frequency of eating particular food-items was associated with the change in eating disorder symptoms, suggesting that especially the reduction of avoidance behaviour is relevant in the decrease of eating disorder symptoms.

Conclusion

The present study showed that although approach tendencies in AN patients increased after one year, they were neither associated with concurrent change in eating disorder symptoms nor predictive for treatment success. This implicates that, so far, there is no reason to add a method designed to directly target approach/avoidance tendencies to the the conventional approach to treat patients with a method designed to influence the more deliberate processes in AN.

Appendix A

Example of an AST-manikin trial

Chapter 7

General discussion

SUCCESSFUL AND UNSUCCESSFUL DIETING

Many people engage in dieting, but most people who start a diet fail, and some dieters eventually gain even more than they initially lost (Elfhag & Rössner, 2010; Jeffery et al., 2000). These people, who are very motivated to control their weight by dieting, but who are often unsuccessful in these attempts, have been referred to as restrained eaters (Herman & Polivy, 1980). Anorexia nervosa (AN patients) on the other hand, belong to the small minority of people who are able to maintain their restrictive eating pattern on the longer term. AN is a highly impairing mental disorder that is characterized by underweight and a disturbed body image. The key question of this thesis was how AN patients, in contrast to most dieters, succeed in maintaining a restrictive eating pattern, while they actually are in a state of starvation.

By nature, food has a high reward value, even more so for people who have been deprived of food, yet AN patients manage to overcome their biological drive to eat. To improve the understanding of this striking phenomenon, two cognitive motivational mechanisms that potentially contribute to the (dys)regulation of eating were studied in AN patients and in restrained eaters. A better understanding of these processes might eventually lead to better treatment options, which can directly target these processes. In this chapter, I will summarize and integrate the finding of the five empirical studies of this thesis (see Table 1 for a global overview of the results). Limitations, implications, and directions for further research will be discussed.

Table 1. *Overview of the results of the studies in the current thesis.*

	RSVP	SRC	AST
Measured construct	Temporal attentional bias	Automatic approach tendencies (food is task-relevant)	Automatic approach tendencies (food is task-irrelevant)
Comparison group	Little attentional capture	Approach bias	No bias
Restrained eaters	High attentional capture (both when food was task-relevant and task-irrelevant)	Reduced approach bias	Positive mood: approach bias
Anorexia patients	High attentional capture when food was task irrelevant	No bias	Avoidance bias

Note. In restrained eaters, a single and a dual target was administered. In AN patients, a single target RSVP was administered. RSVP = rapid serial visual Presentation; SRC= stimulus response compatibility task; AST = affective Simon task, manikin version.

ATTENTIONAL BIAS FOR FOOD

The first cognitive motivational mechanism that was studied, is attentional bias. It has been proposed that there is a reciprocal relationship between selective attention for food cues (attentional bias) and craving. This is assumed to develop as a consequence of associative learning and once established it could be a long-lasting characteristic (Franken, 2003). Following this view, attentional bias would lead to craving for food, whereas in turn, increased craving would strengthen the attentional bias for food. Accordingly, people may end up in a self-reinforcing cycle, which will logically undermine their attempts to restrict their food intake. For AN patients it might, however, be that after prolonged and repeated starvation food loses its motivational salience (e.g., Veenstra & de Jong, 2011), and thereby also its attention grabbing power. If so, this may help prevent AN patients to enter this attentional bias-craving cycle and thus help them in persisting their restrictive food intake.

Previous research provided no straightforward information about the role of attentional bias in disordered eating. Most of these earlier studies on attentional bias in restrained eating exclusively focused on spatial selective attention. Studies found attentional approach, avoidance and no differences, for both AN patients and restrained eaters (see for a review: Faunce, 2002; Werthmann et al., 2015).

Importantly, attention is not only distributed in space, but also in time. The privileged processing of food cues may be especially prominent in the temporal dimension: the consequences of continued attention for food-related information for the processing of other (concurrently or subsequently appearing) information. For example, it could be that food stimuli are processed relatively efficiently and require less attentional resources (lower threshold) to enter people's awareness. Or, once a food stimulus has captured attention, it may be preferentially processed and granted prioritized access to limited cognitive resources (cf. Koster et al., 2009).

Earlier studies on temporal attentional bias in other domains than eating disorders have already shown that salient pictures can capture and hold attention to such a degree that they interfere with the detection of other cues, even after the picture had disappeared (Most et al., 2005). Such privileged access may not only prevent new information from entering working memory, but may also provide the opportunity for more elaborate processing of the food stimulus. Elaboration competes with concurrent cognitive tasks through retrieval of target related information and its retention in working memory (Kavanagh et al., 2005). Consequently, this might lead to craving and eventually food intake, thereby hampering one's diet goal. In contrast, attentional avoidance might prevent that one enters the attentional bias-craving-cycle, thereby facilitating the diet goal.

In the current thesis, this temporal dimension of attentional bias for food was studied in both AN patients and restrained eaters to fill this gap in the literature. In both studies, a Rapid Serial Visual Presentation Task (RSVP) was used. In the RSVP, task stimuli are presented sequentially without interstimulus interval on a computer screen. In every stream of pictures, one or two targets appear, that have to be identified *after* each stream. The deficit in the identification of the second target (T2) has been called the attentional blink, referring to the apparent refractory period following the presentation of the preceding target (T1). Temporal attentional bias can be expressed in different ways within the context of a RSVP task. First, the magnitude of attentional blink can be reduced when T2 is a salient cue and therefore T2 will be identified despite the preceding T1. Secondly, the appearance of a salient T2 (e.g., food) may interfere with the correct identification of a preceding T1. Furthermore, attentional blink can be heightened when T1 is a salient cue and, therefore, the attentional blink will last longer than the usual attentional blink. Lastly, an attentional blink can be elicited when a salient task-irrelevant distractor (e.g., food) is presented shortly before the actual target. The distractor can be ignored but may nevertheless induce an attentional blink.

Temporal attentional bias and restrained eating

The study described in Chapter 2 tested these expressions of temporal attentional biases for food in high versus low restrained eaters. The most critical finding was that specifically in restrained eaters, food distractors elicited an attentional blink. That is, for restrained eaters, neutral targets were less often correctly identified when these were preceded by a food-related as compared to a neutral distractor. This is in line with earlier studies showing that salient distractors can hamper task performance (Most, Scholl, Clifford, & Simons, 2005; Most et al., 2007). Also in the current study participants were, independent of restraint status, distracted by threat pictures, thereby replicating the earlier finding that also negatively valenced stimuli can elicit an attentional blink. The current results thus indicated that even when food cues were presented as task-irrelevant distractors, these food cues nevertheless received prioritized processing in high restrained eaters. In other words, specifically in restrained eaters, food items attracted attention even though these items were irrelevant for their current goal.

Moreover, it was found that also specifically for high restrained eaters, there was an interference effect of a food T2 on identifying the preceding neutral T1. This is in line with previous research, which showed that T2 can have a detrimental influence on the identification of a preceding T1 (Potter et al., 2002). If two targets are presented in close proximity of each other, food cues might win the competition for attention because they receive prioritized access to limited attentional resources and/or are processed more elaborately in high restrained eaters, thereby overriding the previously encoded T1.

Independent of restraint status, the attentional blink was enlarged with a food T1 as compared to a neutral T1. Supporting the view that food cues will receive prioritized processing that comes at the cost of lowering people's ability to identify subsequently presented target stimuli (cf. de Jong et al., 2010), both restrained and unrestrained eaters showed a larger attentional blink with a food T1 as compared to a neutral T1. This finding is in line with the elaborated intrusion theory of desire, which proposes that attention for food cues can automatically trigger intrusive thoughts. These thoughts compete with concurrent cognitive tasks through retrieval of food-related information and its retention in working memory (Kavanagh et al., 2005). However, considering that the food-induced attentional blink was not especially pronounced in high restrained eaters, this effect seems not crucially involved in high restrained eaters' difficulty to maintain their diet regimen. Under condition of a top-down search for food stimuli the differences between restrained and unrestrained eaters may well disappear. Consistent with such view it was observed that both restrained and unrestrained eaters show speeded detection of task-relevant food words compared to detection of neutral words (Hollitt et al., 2010).

Lastly, neither high nor low restrained eaters showed a lowered threshold for identification of food cues. Disinhibited eating in restrained eaters can therefore not be explained by relatively efficient processing of food cues. It seems worth noting that here is a similarity between spatial attentional bias tasks and this type of RSVP trials (food T2 vs neutral T2. Both types of tasks examine efficient processing of food cues, which would facilitate the detection and/or identification of food cues. In the RSVP, it could be that a food T2, as compared to a neutral T2, would be detected more easily, profiting from privileged access to the cognitive system. The absence of a reduced attentional blink for food cues in the present temporal attention task seems therefore consistent with the previous failure to find differences between restrained and unrestrained eaters in spatial attention tasks such as the visual probe task and the exogenous cueing task (Ahern et al., 2010; Boon et al., 2000; Veenstra & de Jong, 2010).

In sum, in Chapter 2 it was shown that food stimuli caused an interference effect in high restrained eaters. This might be the consequence of attempts to suppress stimulus processing, but also reflect more elaborate processing, which is reflected in the associated temporal attention costs (De Ruiter & Brosschot, 1994). Food cues seem to benefit from prioritized access to limited cognitive resources, even if this processing priority interferes with their current task to identify pictures. If food cues remain relatively long in working memory, this may in turn give rise to craving and eventually lead to actual food intake. Also unrestrained eaters show distraction by food cues when task-relevant, but specifically restrained eaters show heightened distraction also when food is task-irrelevant. The finding that this happens even with task-irrelevant distracters, might imply that also in real life, food cues get non-intentional processing priority. So even when involved in activities outside eating, food cues might attract their attention, possibly leading to more elaborate processing, craving and eventually eating.

Temporal attentional bias and anorexia nervosa

Because restrained eaters and unrestrained eaters differed in task performance on the single target RSVP with a food picture as a distracter, it raises the question if AN patients, in contrast, are very efficient in preventing more elaborate processing of food stimuli. Attentional avoidance of high caloric food might help to decrease identification of food in the environment and/or more elaborate processing and thereby preventing food induced craving. If so, this would help AN patients to persist in their strict diet. Therefore, the study in chapter 3 tested the hypothesis that, for instance through prolonged starvation and repeated exposure to food without consequently eating, they are relatively insensitive to the attentional capture and are therefore not distracted by visual food cues. The study used a single target RSVP with food and neutral distracters, administered in a large group of AN patients.

However, results showed the opposite of what was expected. Also in AN patients, we found that, compared to the comparison group, target detection was hampered when it was preceded by a task-irrelevant food distractor. Thus, in contrast with the hypothesis, AN patients showed a similar bottom-up heightened attentional capture by visual food cues that interfered with their current task as we found in the group of unsuccessful dieters (high restrained eaters).

Integration of findings

The finding that the attention-grabbing power of food stimuli was not only present in restrained eaters, but similarly evident in patients with AN, seems inconsistent with the view that temporal attentional bias plays an important role in the pathogenesis of disinhibited eating. Because both groups show a similar temporal attentional bias for visual food stimuli, temporal attentional bias cannot help explaining why AN patients are so successful in maintaining their diet, whereas high restrained eaters typically fail to do so. The only conclusion that can be drawn is that for both successful and unsuccessful dieters, food cues are apparently very salient.

The available findings are silent with regard to the processes underlying the heightened attentional capture of food cues. It might reflect craving and hedonic motivation for food, in line with earlier studies that link temporal attentional bias and craving (Neimeijer et al., 2013; Piech et al., 2009; Schmitz et al., 2015), but the heightened attentional capture of food in successful as well as unsuccessful dieters might also be driven by threatening associations with gaining weight and losing control over eating (Werthmann et al., 2015). Previous studies on temporal bias indicate that also negative stimuli can capture and/or hold attention, and hamper ongoing task performance (e.g., Most et al., 2005; Olatunji et al., 2013; Verwoerd et al., 2010). When a fear-associated stimulus is detected, processing resources are automatically diverted from less salient cues to these feared stimuli to escape the danger as quickly as possible. Hyperattention to feared stimuli can, therefore, facilitate an early escape (Lavy et al., 1993).

The findings therefore fit well with the theoretical model of Field and colleagues (2016), which states that attentional bias arises from momentary evaluations of salient cues: If those cues are evaluated positively, negatively, or both simultaneously (ambivalence), then they will capture attention. It is the overall strength of that evaluation, rather than its valence, that determines the magnitude of attentional bias. The evaluation can vary from moment to moment depending on the current motivational orientation to consume the food or to refrain from consuming it (Field et al., 2016). The interindividual and moment-to-moment variation in restrained eaters might be large: Some restrained eaters might associate food especially with the positive aspects of eating, whereas for others, or at other moments, food is associated especially with the more negative aspects (e.g., of gaining weight). At any moment, food remains salient for restrained eaters. Earlier research on automatic associations in restrained eaters indeed found mixed results. Evidence for positive (Hoefling & Strack, 2008; Houben et al., 2010) and negative associations were found (Maison et al., 2001; Papies et al., 2009), and one study did not find a relationship between implicit measures of affective associations with high caloric food and restraint status (Roefs et al., 2005).

An attentional bias for food in AN might reflect fear of gaining weight or losing control over eating and could contribute to dietary restraint and (behavioural) avoidance of food stimuli. Additional factors, apart from heightened attention, seem to be involved in why restrained eaters enter the attentional bias-craving-eating cycle, whereas AN patients do not. Given the difference in actual eating behaviour, AN patients seem able to avoid further processing after initial attentional capture, or they possibly have high top-down self-regulation skills to resist food-related short-term reinforcement. This is in line with the idea that bottom-up and top-down systems exert mutual influences on each other to determine whether thoughts and actions are engaged on adaptive goals, or on the processing of salient information that is unrelated to current goals (Mogg & Bradley, 2016).

APPROACH AND AVOIDANCE TENDENCIES FOR FOOD

Once food is in the centre of attention, food can be evaluated and the automatic behavioural tendency of approaching (or avoiding) the food can be activated. A tendency to automatically approach food might interfere with the deliberate intention to avoid food, whereas an avoidance bias would facilitate the diet intention. Therefore, the second cognitive motivational process that was studied in the current thesis, was this automatic approach bias for food. The Chapters 4, 5, and 6, presented studies on approach and avoidance tendencies in restrained eaters and AN patients.

Automatic approach tendencies across situations

A bias to approach food might play a role during a mealtime, where one has to choose what and how much to eat. Strong approach tendencies may then affect both the selection of food (e.g., approach tendencies may be stronger for high than for low caloric food items) and the amount of food-intake. If the goal is to restrict food intake, one can use all cognitive resources during a meal to regulate food intake in an attempt to achieve that goal. Whether automatic approach tendencies have a decisive influence on eating behaviour during a mealtime might therefore be dependent on the presence of a goal to restrict food intake and on the ability to act in line with that goal.

Automatic approach tendencies towards food might also be elicited in situations where food is irrelevant for one's current task. For example, when passing a chocolate shop while shopping for new clothes, one might be seduced by the sight of chocolate. Outside a regular mealtime one is less actively thinking of the diet goal and consequently self-control might be less. So especially also when food is irrelevant for the current task and someone is doing something else, approach tendencies might be elicited when food is (unexpectedly) seen or smelled.

In an attempt to model both types of situations, two different computer tasks were used to measure automatic approach tendencies: An Affective Simon Task manikin version (AST) and the Stimulus Response Compatibility task (SRC). Because food is relevant for correct task performance in the SRC (i.e., the correct response is determined by the presence of food), this task models situations where the person is deciding what and how much to eat, such as during a mealtime. Especially when high caloric food items elicit strong automatic approach tendencies, this may influence people's food selection that is inconsistent with their diet goal. Conversely, because food is irrelevant to correct task performance in the AST (i.e., the correct response is determined by another feature than food/non-food, such as top/side view perspective), this task models situations where the person is performing a different task, such as walking to work, but is tempted to eat, for example, by the smell of bread when passing a bakery.

Automatic approach tendencies in restrained eating

In Chapter 4, automatic approach tendencies were studied in restrained and unrestrained participants in a first attempt to directly compare both computer tasks in the context of food. Additionally, the influence of mood was examined. A neutral, positive, sad or stressed mood was induced, before the two approach avoidance tasks were administered. Afterwards, participants performed a bogus taste task to assess their level of food consumption to test whether there was a relationship between mood and actual eating, that is mediated by automatic approach tendencies towards food.

When in a positive mood condition and when food was task-irrelevant, restrained eating was associated with stronger approach tendencies toward high caloric food. This is in line with several studies pointing to increased food intake during positive emotions for eating- or weight concerned people (e.g., emotional and restrained eaters: Bongers et al., 2013; Yeomans & Coughlan, 2009). Positive emotions might lead to food indulgence, because happiness promotes impulsive and non-reflective processing. Especially in restrained eaters this may consequently lead to heightened approach behaviour inconsistent with conscious intentions (Schwarz & Bless, 1991). In other words, in restrained eaters, a positive mood might activate food-approach associations.

Following a negative mood induction, restrained eaters showed less approach bias than unrestrained eaters. This suggest that unrestrained eaters show a heightened approach tendency toward food when in a negative mood compared to a positive mood. Food can be consumed to provide comfort or distraction from negative emotions and when this happens regularly, it will become associated with aspects of the preceding negative state (Deutsch & Strack, 2006). So, results point to the conclusion that whereas for unrestrained people a negative mood leads to more approach tendencies, for restrained eaters a positive mood leads to heighted approach for food.

In line with their diet goal, restrained eaters showed, independent of mood, less approach towards food when food was task-relevant (as measured with the SRC), as compared to unrestrained eaters. These findings are consistent with previous research showing that restrained eaters displayed less approach bias when automatic approach tendencies were measured with a task in which food was a task-relevant feature (Fishbach & Shah, 2006). Approach tendencies as measured with the SRC appeared to be consistent with their diet goal.

Approach bias measured with the AST was not unconditionally related to restrained eating. The finding that the AST approach bias for high and low caloric food was not generally heightened in participants with relatively high scores on the Restraint Scale seems inconsistent with the previous finding that especially restrained eaters showed a heightened approach bias for food as indexed by the AST (Veenstra & de Jong, 2010). However, there were several differences between the study of Veenstra and de Jong (2010) and the current study, which might help explain the differences in outcomes. Most important, in the current study, participants underwent a mood induction prior to the AST, which influenced the approach bias. It could be argued that healthy people are by default in a positive mood, so this could explain why in both studies restrained eaters show heightened approach. One way to attain a more final conclusion is to directly compare restrained eaters after a positive mood induction versus no mood induction.

Automatic approach tendencies in anorexia nervosa

The finding that, at least in a positive mood, restrained eaters showed heightened approach tendencies if food is task-irrelevant, raised the question whether AN on the other hand might show reduced approach tendencies or even avoidance tendencies when exposed to food cues. In Chapter 5, automatic approach tendencies in AN versus a comparison group without an eating disorder were therefore studied using two types of approach-avoidance tasks. Results indicated that indeed AN patients show less automatic approach tendencies than the comparison group without an eating disorder both measured with the SRC (task-relevant) and with the AST (task-irrelevant). These findings are consistent with earlier studies using indirect measurement procedures to examine the more automatic approach responses toward food in AN (Paslakis et al., 2016; Veenstra & de Jong, 2011).

Specifically the SRC showed an independent relationship with the presence of AN, indicating that lowered automatic approach for food during a mealtime is most crucial in AN. The outcomes might help explain why AN patients, in contrast to restrained eaters, are able to comply to their deliberate intention to restrain from food even in situations where self-control is impaired and even when they are in a state of starvation. Perhaps as a result of repeated exposure to food without eating, food might have lost its incentive value in AN patients (Pinel et al., 2000). In support of this, AN patients showed a reduced self-reported desire for high-fat foods (Stoner, Fedoroff, Andersen, & Rolls, 1996). In addition, there is evidence indicating that also at the more automatic level AN patients failed to show positive affective associations with palatable food compared to a comparison group (Roefs et al., 2005).

With regard to low caloric food, AN patients showed heightened approach for task-relevant food pictures. An approach bias for low caloric food could help them with their diet intention, when combined with a lowered approach bias for high caloric food. In line with the idea that approach bias for low caloric food can protect someone from eating high caloric food, a study showed that specifically in individuals with *low* approach tendencies for healthy (low caloric) food, hunger positively predicted sweet consumption (Cheval, Audrin, Sarrazin, & Pelletier, 2017).

Integration of the findings

Integrating the findings of studies on approach tendencies in disordered eating, it seems that SRC performance is more consistent with participants' diet goal than with their success in restricting their food intake. Whereas the unrestrained comparison groups (no diet goal), showed an approach bias, participants with a diet goal showed a reduced (restrained eaters) vs. no approach bias for food (AN patients). This might implicate that top-down processes (for instance their explicit diet goal) have an influence on the performance during the SRC task.

The finding that the unrestrained comparison group exhibited approach towards food, is reminiscent to findings of research in the context of alcohol. Social drinkers (as an analogue for unrestrained eaters) who did not have the goal to reduce their alcohol intake, showed an approach bias for alcohol as measured with the SRC (Field et al., 2011). Treatment seeking samples (as an analogue for restrained eaters) might show, in line with their goal, reduced approach tendencies for alcohol when assessed with the SRC. However, especially those who fail to profit from treatment and are not able to resist the temptation to drink might show heightened approach tendencies on de AST. This might explain why restrained eaters might show an approach when food is task-irrelevant (as a model for temptations), but an avoidance bias when food is task-relevant. That however also the SRC seems to be related to actual behaviour is supported by the finding that specifically this task is uniquely related to the presence of AN.

It must be mentioned that results of Chapter 4 and 5 cannot be directly compared, because of the methodological differences. For instance, in the study on restrained eaters, various mood states were induced. The question remains whether AN patients also show differential effects with regard to their approach/avoidance tendencies in the AST, under influence of a positive or negative mood. One could speculate that, because AN is a highly impairing disorder and the comorbidity with depression is high, AN patients by default have a lowered mood state. If we assume that AN patients in general have a lowered mood, it can be concluded that they show the same pattern as restrained eaters in a negative mood. The effect found in AN patients is, however, even more pronounced than for restrained eaters in a negative mood: Whereas restrained eaters showed a reduced approach bias compared to the unrestrained comparison group, AN patients even showed an avoidance bias of high caloric food.

The course of approach tendencies in anorexia nervosa

A next question that raises after the findings in Chapter 5, is whether approach /avoidance tendencies change over time and whether recovery from an eating disorder critically depends on normalizing approach tendencies towards food. The study described in Chapter 6 therefore used a longitudinal design, in which approach tendencies for food and eating pathology of a large group of AN patients were measured at the moment of intake and at a fixed subsequent assessment at one-year follow up.

Results showed that automatic approach bias as measured with the AST generally recovered back to normal (i.e., to the level of the comparison group without an eating disorder), and patients also improved in terms of weight and eating disorder related cognitions. However, recovery of approach tendencies for high caloric food was not directly associated with a reduction of the eating disorders symptoms. This holds for at least the relatively short-term outcome, that is, one year after start of treatment.

Although treatment did not focus directly on changing automatic processes, the findings support the possibility that treatment does have an effect on approach tendencies, because there was no approach bias for high caloric food at T1, whereas there was at T2. The suggestion that treatment methods that focus on the more deliberate processes can be in itself also responsible for changing automatic processes, is in line with the idea that automatic processes may develop through the acquisition of new information that changes higher order beliefs, which in turn modify functionally-related lower order automatic processes (Mansell, 2000). Accordingly, although automatic processes can operate without conscious control, voluntary processes can be responsible for changes in automatic processes. However, no final conclusions can be drawn at this point because it was ethically unacceptable to include a waitlist/no treatment control condition in this group of under-aged patients with a severe psychiatric disorder. Also learning/practice effects of the baseline measure on the follow up measure cannot be ruled out.

The finding that recovery of approach tendencies for high caloric food was not directly associated with reduction of the eating disorders symptoms was not in line with our expectations, but there are several possible explanations for this. First of all, in this study only the AST was administered. Initially, treatment focusses especially on normalizing eating pattern and weight restoration (Fairburn et al., 2008). In line with this, after one year, the frequency of eating the specific food items was increased. It might be that approach tendencies during a meal (as modelled by the SRC) are more associated with recovery since eating during mealtimes is a first step in treatment. It would be helpful doing further longitudinal research on this topic also with a task with food as a task-relevant measure and to test whether specifically change in the SRC index is associated with the initial reduction of eating disorder symptoms.

Secondly, it might be that the relationship automatic approach/avoidance tendencies and eating disorder symptoms is not linear. The treatment of AN is firstly focused on regaining weight and normalizing the eating pattern. By approaching the food the automatic tendency to avoid is then overruled by explicit actions (i.e., eating). By regularly doing this, automatic associations might eventually change as well. The absence of a straightforward relationship between improvement as indexed by body weight and eating disorder symptoms (EDE-Q) and improvement as indexed by increased approach tendencies towards food, may therefore imply that some patients have learned helpful cognitions but did not yet experience a change at the more automatic level. It could also be that the opposite is true: Automatic approach tendencies might change by normalizing the eating pattern in treatment, but concerns about eating, weight and shape (and thereby high EDE-Q scores) may first remain.

An important next step would be to find out whether patients in whom EDE-Q scores, but not approach tendencies toward food, changed in a favourable way, are at a relatively high risk for relapse. Germane to this, a recent study in the context of speech anxiety showed that the strength of residual negative automatic associations with speaking in public after successful treatment had predictive value for the return of fear (Vasey et al., 2012). In analogy, absence of automatic approach tendencies toward food might be associated with a higher chance of a return of eating disorder symptoms over the course of multiple years.

In addition, it is known that eating disorders can change from one into another (Fairburn et al., 2003). For example, BN typically starts as AN or an atypical eating disorder (e.g., Sullivan, Bulik, Fear, & Pickering, 1998). Disorders that persist from adolescence to adulthood commonly change from a restricting AN picture to one more typical of BN, and could be viewed as a phase in the course of the eating disorder (Eddy et al., 2002). This transdiagnostic perspective on the maintenance of eating disorders raises the question if automatic approach tendencies change during transitions between different eating disorders. Stronger approach tendencies at the onset of the eating disorder in an individual with AN could increase the chance of binging and thereby developing BN. One way to test this would be to follow eating disorder patients for a long period of time.

COGNITIVE PROCESSES IN EATING DISORDERS: INTEGRATION OF FINDINGS

To summarize, it was found that both restrained eaters and AN patients, showed heightened distraction by food cues. For both groups, the food stimuli appeared to be very salient, but the process underlying this saliency (e.g., craving / threat) remains unclear, and the finding does not explain the difference in eating behaviour between both groups. One reason that AN patients restrain from actual eating is that once food stimuli are detected, an automatic tendency to avoid food is activated, both when food is relevant and when food is irrelevant for their current task. Restrained eaters in contrast, show in a positive mood and when food is irrelevant for their current goals, a heightened approach bias for food, which may increase the chance of actual eating.

Strengths, limitations and future directions

A strength of this thesis is that the clinical studies all consisted of a relatively large group of AN patients. An important limitation is however the correlational nature of the studies. On the basis of the thesis, it cannot be determined whether the measured cognitive processes are a characteristic that is present before the onset of eating problems, or whether these processes are a symptom/ expression of the eating disorder, and are thereby just epiphenomena. A critical next step is to test to what extent heightened approach tendencies play a causal role in the inability to maintain one's diet in restrained eaters and whether lowered approach tendencies are crucial in the persistence of AN.

There is evidence that a food-related approach bias can be successfully retrained, and that actual food consumption can be reduced following a cognitive bias modification (see for a review: Kakoschke, Kemps, & Tiggemann, 2017). A study using a cognitive modification procedure that trained participants to move a manikin towards or away from chocolate, had the predicted effect on approach bias: Participants trained to approach chocolate demonstrated an increased approach bias to chocolate stimuli whereas participants trained to avoid such stimuli showed a reduced bias (Schumacher et al., 2016). Further, participants trained to avoid chocolate ate significantly less of a chocolate muffin in a subsequent taste test than participants trained to approach chocolate. Thus, modifying automatic approach tendencies can not only have an influence on the tendencies itself, but also on actual behaviour. Perhaps, restrained eaters could benefit from a training designed to decrease their approach tendencies, whereas AN patients could be trained to increase their approach tendencies. One could argue that (absence of) approach tendencies during mealtime seem most crucial in whether a person is able to maintain a diet, so it seems a logical step to start with the SRC.

However, the application of such a bias modification training in AN patients, also comes with several ethical and practical challenges, such as the potential risk of inducing binge eating. Another concern is that the training of approach tendencies without direct food consumption afterwards might contribute to a (further) extinction of the appetitive response towards food in anorexia patients, as an analogy with cue exposure in which the association between the presence of food and subsequent eating is attenuated (Jansen, 2016).

With regard to the studies on temporal attentional bias, in both studies the hunger scale was administered. There appeared to be no difference in hunger between restrained and unrestrained individuals. AN patients displayed less subjective hunger but a longer time since last meal, but the effects of the study remain the same when controlled for hunger. An interesting next question would be if temporal attentional bias varies under the influence of hunger for both groups. One would expect that hunger (caloric restriction) increases the incentive value and would thereby also increase the attentional bias, especially for restrained eaters. Earlier research using a RSVP in hungry and satiated participants indeed showed that hunger increased the attentional blink (Piech et al., 2009). To test this, a RSVP task can be administered in both groups directly after a meal, or after hours of abstinence. Because AN patients are in a chronic state of starvation one might expect that for restrained eaters, temporal attentional bias varies more under the influence of hunger than for AN patients. If hunger increases the attentional bias in restrained eaters, this might promote food intake, also the food that one has not planned to eat.

Further, a next step would be to determine whether temporal attentional bias decreases together with a decrease in dysfunctional eating behaviour. One could expect that when the eating pattern normalizes, food cues become less salient and thereby the temporal attentional bias becomes less pronounced. A remaining temporal attentional bias might hinder recovery. This might yield for both groups, although the underlying reason for the temporal attentional bias might be different. If the threat value of food gives rise to the temporal attentional bias for food stimuli, it may be important for recovery to reduce this threat value (cf. Olatunji, Armstrong, McHugo, Zald, 2013). Also, when temporal attentional bias is related to craving, it might be effective for normalizing the eating pattern to reduce the attentional bias (cf. Kemps, Tiggemann, Orr, Grear, 2014). Thus, normalizing the preoccupation with food might help to normalize the eating pattern.

Another limitation concerns the generalizability of the results. The clinical studies described in Chapter 3, 5, and 6, consisted of adolescents with AN. It could be that due to shorter durations of illnesses these automatic cognitive processes are less ingrained and therefore less pronounced than in adults. If so, then would automatic avoidance for food in adults with AN contribute even more to the persistence of AN. It is therefore important to also study automatic approach tendencies (using an AST ad SRC) in adult patients with AN.

With regard to the studies with restrained eaters, participants were predominantly young, highly educated, and were normal to slightly overweight, so it remains unclear whether results can be generalized to overweight participants or to a wider age range. It would be interesting to replicate the study in a more heterogeneous participant group.

CONCLUSION

The studies in the current thesis addressed the critical issue why some people are so proficient in restricting their caloric intake, whereas others systematically fail and overeat. In short, the research presented in the current thesis provided results that are consistent with the idea that both temporal attentional bias and differential approach-avoidance tendencies are involved in disordered eating. Both restrained eaters and AN patients showed a heightened attentional capture by food cues. This does not explain the differences between two groups, but temporal attentional bias might maintain both types of disordered eating. Especially when in a positive mood, restrained eaters showed heightened approach for task-irrelevant food stimuli, which might interfere with their diet goal. AN patients showed a reduced automatic approach tendency toward high caloric foods both when food was task-relevant and when food was task-irrelevant. Especially the reduced approach tendency when food was task-relevant and could not be ignored seemed the most critical characteristic of patients with AN. This reduced automatic approach tendency might help explain why AN succeed in complying to their intentional strategy to restrict their food-intake even in a condition of starvation. Although approach tendencies increased after one year, these were neither associated with concurrent change in eating disorder symptoms nor predictive for treatment success. Future research is needed to determine whether this also applies when food is task relevant and to determine whether normalizing automatic approach tendencies towards food predict treatment success on the longer term.

Nederlandse samenvatting

Hoe kan het dat de meeste mensen die proberen te lijnen, ondanks hun sterke wens om gewicht te verliezen, hun dieet niet volhouden, terwijl mensen met Anorexia zichzelf blijven uithongeren? Dat is de vraag die centraal staat in dit proefschrift.

ACHTERGROND

Anorexia Nervosa (AN) is een psychische stoornis waarbij iemand een intense angst heeft om aan te komen, ook al heeft die persoon ondergewicht (American Psychiatric Association, 1994). Lichaamsvormen en gewicht en de controle hierover zijn extreem belangrijk geworden voor hoe degene over zichzelf denkt (Fairburn, Cooper, & Shafran, 2003). AN heeft ernstige consequenties voor de lichamelijke toestand en de kwaliteit van leven. Van alle psychische stoornissen heeft AN het hoogste sterftepercentage (Sullivan, 1995). Anorexia komt het meest voor bij vrouwen. Van alle vrouwen krijgt iets minder dan 1 procent ooit AN (Hudson, Hiripi, Pope, & Kessler, 2007).

Veel mensen, voornamelijk vrouwen, proberen gewicht te verliezen door te lijnen. De meeste mensen die proberen te lijnen slagen er echter niet in om hun lijngedrag voor langere tijd vol te houden. Ze vervallen in hun oude eetgedrag en eten precies de producten die ze zo graag hadden willen vermijden. Hoe kan het dat het mensen met AN, ondanks dat ze uitgehongerd zijn, wel lukt om zich aan hun dieetregels te blijven houden? In dit proefschrift zijn twee cognitief motivationele processen onderzocht die hier mogelijk aan bijdragen.

TEMPORELE AANDACHTSBIAS

Een mogelijk verschil tussen succesvolle (AN patiënten) en onsuccesvolle lijners betreft aandachtsbias. Het zou kunnen dat AN patiënten relatief ongevoelig zijn voor de verleidelijke aspecten van eten en dat hun aandacht daardoor minder snel automatisch naar voedsel getrokken wordt. De wereld om ons heen is vol van prikkels en niet alles kan door iemand verwerkt worden. Saillante stimuli trekken de aandacht, terwijl ander stimuli niet eens opgemerkt worden. Als een stimulus eenmaal is waargenomen kan dit tot 'craving' leiden. Deze craving kan ervoor zorgen dat voedsel alleen nog maar meer aandacht trekt en kan er daarmee voor zorgen dat iemand uiteindelijk gaat eten (Franken, 2003).

Als AN patiënten niet gevoelig zijn voor deze verleidelijke eigenschappen van eten, kan het hen helpen om niet in deze cirkel van aandachtsbias – craving – eten terecht te komen. In tegenstelling tot AN patiënten zouden lijners juist heel gevoelig zijn voor de verleidelijke kenmerken van voedsel en een grote aandachtsbias kunnen vertonen. Eerder onderzoek liet echter geen duidelijke ondersteuning voor dit idee zien (zie voor een review bijvoorbeeld Werthmann, Jansen, & Roefs, 2015). Een verklaring hiervoor kan zijn dat het meeste onderzoek naar aandachtsbias in de context van eten zich heeft beziggehouden met spatiale aandachtsbias, oftewel aandacht die naar een bepaalde plek toe of er vandaan wordt getrokken. Aandacht is echter niet alleen spatieel (oriënteren van aandacht op een bepaalde plek), maar ook temporeel (in tijd) verdeeld. Met temporele aandacht wordt bijvoorbeeld bedoeld dat de drempel om saillante informatie waar te nemen lager kan liggen dan voor niet-saillante informatie, waarna prioriteit gegeven wordt aan verwerking hiervan. Het prioriteit geven aan het verwerken van de saillante informatie kan ook tot gevolg hebben dat bepaalde informatie die hier vlak voor of vlak na verschijnt, gemist wordt. Er is nog heel weinig onderzoek gedaan naar aandachtsbias in het temporele domein in de context van voedsel terwijl dit mogelijk wel relevant is. In dit proefschrift werd temporale aandachtsbias daarom onderzocht in zowel adolescenten met AN als in onsuccesvolle lijners. Hiervoor werd een Rapid Serial Visual Presentation (RSVP) taak gebruikt. In deze taak wordt een stroom plaatjes in hoog tempo achter elkaar vertoond op een computerscherm. In elke stroom verschijnen een of twee 'targets': plaatjes die moeten worden geïdentificeerd. Fundamenteel onderzoek naar temporele aandachtsbias liet zien dat een tweede target (T2) vaak gemist wordt als deze kort na de eerste target (T1) verschijnt. Het missen van de T2 wordt ook wel de 'attentional blink' genoemd: een kort moment waarin iemand niet is staat is nieuwe informatie op te nemen. Temporale aandachtsbias kan zich op verschillende manieren uiten. Ten eerste kan de lengte van de attentional blink worden verkort als T2 een saillant plaatje is. Hierdoor wordt T2 toch geïdentificeerd, ook al verschijnt deze kort na de T1. Ten tweede kan deze T2 ook voor problemen zorgen bij het identificeren van de voorafgaande eerste target (T1). Het eerste plaatje wordt als het ware overschreven door het eerder vertoonde saillante plaatje. Hierdoor kan het plaatje langer in het werkgeheugen blijven. Ten derde kan de attentional blink ook verlengd worden als de T1 erg saillant is. Ook hierdoor blijft het plaatje langer in het werkgeheugen. Als het voedselplaatje de aandacht langer vasthoudt ontstaat er minder ruimte om nieuwe informatie op te nemen en vergroot dat de kans om trek in eten (craving) uit te lokken. Tot slot kan een attentional blink zelfs optreden wanneer een afleidende stimulus (die in tegenstelling tot de target niet hoeft worden geïdentificeerd) wordt vertoond vlak voor de target. Deze afleidende stimulus zou genegeerd kunnen worden, maar kan toch voor afleiding zorgen en daarmee de taakprestatie verminderen.

Hoofdstuk 2: Temporele aandachtbias bij lijners

In Hoofdstuk 3 werd temporele aandachtsbias bij 40 lijners en 40 niet-lijners onderzocht. De meest belangrijke bevinding van deze studie was dat, specifiek voor lijners, een afleidende voedselstimulus voor een attentional blink zorgde. Dat betekent dat bij lijners neutrale targets minder vaak correct werden geïdentificeerd als er een voedselplaatje aan voorafging, dan wanneer er een neutraal plaatje aan voorafging. Dus ook al kon het afleidende voedselplaatje worden genegeerd, trok deze toch de aandacht bij lijners. Verder werd gevonden dat specifiek bij lijners een voedselstimulus voor een 'backward blink' zorgde, oftewel problemen bij het identificeren van de T1 als de T2 een voedselplaatje was. Het voedselplaatje bleek als het ware het eerder vertoonde plaatje overschrijven. Ook werd gevonden dat bij zowel lijners als niet-lijners voedselstimuli als T1 voor een langere attentional blink zorgden, vergeleken met een neutrale T1. Tot slot zorgden voedselstimuli als T2 niet voor een kortere attentional blink vergeleken met neutrale stimuli. Voedselstimuli werden dus niet vaker waargenomen dan neutrale stimuli in de tijd vlak na het vertonen van een plaatje, waarin veelal informatie gemist wordt.

Samengevat liet het patroon van bevindingen in Hoofdstuk 2 zien dat voedselstimuli veel aandacht kregen bij lijners, wat tot gevolg had dat andere stimuli gemist werden. Dit gebeurde zelfs wanneer het om de taak goed te kunnen doen, beter was om de voedselplaatjes te negeren. Als voedselstimuli lang in het werkgeheugen blijven, kan dit de kans op craving en uiteindelijk voedselinname vergroten. Deze temporele aandachtsbias lijkt dan ook te helpen verklaren waarom lijners moeilijkheden hebben met het volhouden van hun dieet.

Hoofdstuk 3: Temporele aandachtsbias bij AN

Een vraag die deze uitkomsten opriepen, is of AN patiënten dan juist heel ongevoelig zijn voor de aandachtstrekkende kracht van voedselplaatjes. Ongevoeligheid voor voedselcues kan verdere verwerking voorkomen en daarmee ook het ontstaan van craving en voedselinname. In hoofdstuk 3 werd daarom een RSVP met afleidende neutrale en voedsel plaatjes afgenomen bij 66 jongeren met AN en 55 controles zonder eetstoornis. In tegenstelling tot de initiële verwachting, lieten AN patiënten, in vergelijking met controles, juist een relatief sterke gevoeligheid zien voor voedselplaatjes. Een mogelijke verklaring voor deze onverwachte bevinding zou kunnen zijn dat voor AN de plaatjes in hoge mate als dreigend werden ervaren. Eerder onderzoek heeft namelijk al laten zien dat een temporele aandachtbias niet alleen samenhangt met craving, maar ook dreiging. Geconcludeerd werd dus dat zowel voor lijners als AN patiënten voedselplaatjes saillant zijn maar het onderliggende proces dat hiertoe leidt (bijvoorbeeld dreiging / craving) kan op basis van dit onderzoek niet worden vastgesteld.

AUTOMATISCHE NADERNEIGING

Als voedsel eenmaal in het centrum van de aandacht is, kan de automatische neiging tot het naderen of het vermijden hiervan worden geactiveerd. Een automatische neiging om voedsel te naderen interfereert met iemands dieet, terwijl een automatische neiging om voedsel te vermijden juist zou kunnen helpen om het dieet vol te houden. Het tweede cognitief motivationeel proces dat was onderzocht is daarom deze automatische neiging tot het naderen of vermijden van voedsel. Er zijn verschillende situaties denkbaar waarin een relatief sterke neiging om voedsel te naderen het doel om te lijnen kan tegenwerken. Ten eerste zou het tijdens eetmomenten (bijvoorbeeld in een maaltijd) de keuze en hoeveelheid van het eten kunnen beïnvloeden. Zo zou een sterke automatische naderneiging voor hoogcalorisch voedsel in de kantine bijvoorbeeld kunnen leiden tot de keuze van friet in plaats van een salade die beter past binnen je dieet. Een taak die geschikt lijkt om automatische naderneiging tijdens de maaltijd te meten is de Stimulus Response Compatibility (SRC) taak. In de SRC verschijnt een plaatje van voedsel op het scherm, met daarboven of daaronder een poppetje. Deelnemers moeten deze naar het plaatje toe laten rennen of er juist vanaf, afhankelijk van de inhoud van het plaatje (voedsel/ geen voedsel). In deze taak is voedsel taakrelevant, dat betekent dat de respons van de onderzoeksdeelnemer afhankelijk is van of het plaatje voedsel of geen voedsel is. Omdat voedsel taakrelevant is, kan deze taak model staan voor situaties in het echte leven waarin voedsel relevant is voor wat iemand op dat moment aan het doen is (zoals een maaltijd), waarin iemand geacht wordt eten te selecteren.

Voedsel kan echter ook de neiging te naderen uitlokken in situaties waarin voedsel niet relevant is voor iemands bezigheden op dat moment. Bijvoorbeeld, als iemand op weg is naar werk, kan hij of zij afgeleid worden door de geur van een bakkerij of door het zien van een chocolade-reclame. Buiten eetmomenten om is iemand minder bezig met zijn of haar dieet en daardoor is de zelfcontrole mogelijk niet optimaal. Om automatische naderneiging te meten, wanneer voedsel niet relevant is voor de taak die je op dat moment moet doen, werd een Affectieve Simon Taak (AST) gebruikt. In de AST hangt de verwachte respons af van een kenmerk van een plaatje dat niets te maken heeft met voedsel. De onderzoeksdeelnemer moet bijvoorbeeld het plaatje naderen als het plaatje een bovenaanzicht betreft, en vermijden als het een zijaanzicht betreft. Omdat voedsel niet relevant is voor de taak, staat de AST model voor situaties waarin iemand niet met eten bezig is, maar toch verleid kan worden en vervolgens voor de bijl kan gaan. De Hoofdstukken 4, 5 en 6 beschrijven studies over automatische naderneiging in verschillende situaties, bij AN patiënten en bij lijners.

Hoofdstuk 4: Automatische naderneiging bij lijners

De studie in Hoofdstuk 4 toetste of lijners gekenmerkt worden door een verhoogde naderneiging voor voedsel. Eerder onderzoek op het gebied van automatische naderneiging bij lijners was niet consistent en vond zowel een naderneiging, als een neiging om voedsel te vermijden. Mogelijk komt dit omdat er geen onderscheid gemaakt werd tussen een computertaak waarbij voedsel taakrelevant was (de SRC) en een computertaak waarbij voedsel taakirrelevant was (de AST) (Fishbach & Shah, 2006; Veenstra & de Jong, 2010). Ten tweede ging het hoofdstuk in op de vraag of stemming de naderneiging beïnvloedde. Een hypothese was dat automatische naderneiging niet vastligt, maar die het kan fluctueren onder verschillende omstandigheden, bijvoorbeeld onder invloed van stemming. Er zijn zowel aanwijzingen dat een negatieve, als dat een positieve stemming tot voedselinname zou kunnen leiden (Baker et al., 1986).

Om de hypotheses te toetsen, deden 92 vrouwelijke onderzoeksdeelnemers die varieerden in lijngedrag, een SRC en een AST. Voorafgaand aan de taken werd een sombere, gespannen, neutrale of positieve stemming geïnduceerd. De studie toonde aan dat, in overeenstemming met hun lijndoel, onderzoeksdeelnemers die in sterke mate lijnden, onafhankelijk van stemming, een relatief zwakke automatische naderneiging voor voedsel lieten zien wanneer voedsel taakrelevant was (net als tijdens een maaltijd). Dit zou hen kunnen helpen om zich aan hun lijnintenties te houden. Echter, in een positieve stemming en wanneer voedsel taakirrelevant was, vertoonden lijners een sterke automatische neiging om voedsel te naderen. Dit is in lijn met eerder onderzoek dat vond dat een positieve stemming de invloed van automatische processen versterkt. De sterke automatische neiging om voedsel te naderen kan interfereren met hun dieetdoel en kan mogelijk verklaren waardoor lijners hun lijngedrag vaak niet volhouden.

Hoofdstuk 5: Automatische naderneiging bij AN

De resultaten uit Hoofdstuk 4 riepen de vraag op of AN mogelijk dan een verminderde automatische neiging om voedsel te naderen vertonen, of zelfs een neiging hebben om voedsel op automatisch niveau te vermijden. Als AN patiënten zich hierdoor kenmerken dan kan hen dat ondersteunen bij hun bewuste intentie om te lijnen. Eerder onderzoek toonde aan dat patiënten met AN inderdaad een minder sterke automatische naderneiging vertonen dan controles met een gezond gewicht (Paslakis et al., 2016; Veenstra & de Jong, 2011). Deze eerdere onderzoeken zijn echter alleen gedaan met een computertaak met voedsel als taakirrelevant kenmerk. Dit representeert situaties buiten een eetmomenten om, waarbij iemand mogelijk toch verleid kan worden om het eten te naderen. Een onbeantwoorde vraag is nog of AN patiënten ook in een eetsituatie minder automatische naderneiging vertonen. Om te kunnen bepalen of AN patiënten ook een verminderde naderneiging vertonen als voedsel taakrelevant is, en dus niet genegeerd kan worden, en om beide paradigma's rechtstreeks te kunnen vergelijken is de studie in Hoofdstuk 5 uitgevoerd.

In deze studie werden de beide computertaken afgenomen in 63 AN patiënten en in 57 controles bestaande uit jongeren zonder eetstoornis. Zowel wanneer voedsel taakrelevant als wanneer voedsel taakirrelevant was, lieten AN patiënten een verminderde naderneiging voor voedsel zien. Specifiek de SRC (waar voedsel taakrelevant is) kon op zichzelf de aanwezigheid van AN voorspellen. Concluderend lijkt verminderde naderneiging voor voedsel in verschillende situaties, maar met name een automatische neiging om voedsel te vermijden in maaltijdsituaties, bij te dragen aan de hardnekkigheid van AN. Het kan verklaren waarom patiënten met AN hun dieetgedrag volhouden, ondanks dat ze in een uithongeringstoestand zijn.

Hoofdstuk 6: Automatische naderneiging en het verloop van AN

Als verminderde automatische naderneiging cruciaal is voor het voortduren van AN-klachten, zou een vermindering van de klachten moeten samengaan met een vermindering om voedsel te naderen. Verder is het goed denkbaar dat automatische naderneiging bij het begin van de behandeling voorspellend is voor eetstoornissymptomen in de toekomst, als verminderde automatische naderneiging belangrijk is voor het beloop van AN. Om te toetsen of dit klopt, beschrijft Hoofdstuk 6 daarom een longitudinale studie waarin AN patiënten bij start van de behandeling gemeten en nogmaals na een jaar follow up.

Tijdens de meting direct na de intake vertoonden AN patiënten, gemeten met de AST, alleen een automatische naderneiging voor laagcalorisch voedsel. In de vervolgmeting een jaar later bleek dat ze zowel voor hoog- als laagcalorisch voedsel een automatische naderneiging hadden. Dus na een jaar lieten AN patiënten een zelfde patroon als de controlegroep zonder eetstoornis zien. Hoewel deze bevinding in overeenstemming is met het idee dat automatische naderneiging belangrijk is voor het beloop van AN, bleek de sterkte van deze automatische naderneiging niet samen te hangen met de mate van behandelsucces. Dus, verminderde naderneiging bleek geen obstakel voor een vermindering van eetstoornissymptomen. Dit was niet in overeenstemming met de verwachting. Verschillende verklaringen hiervoor zijn denkbaar, bijvoorbeeld dat niet de AST, maar juist de SRC voorspellend is voor behandelsucces en dat mogelijk vooral het terugkeren van automatische naderneiging tijdens maaltijden het meest belangrijk is voor het herstel van AN .

CONCLUSIE

De studies in dit proefschrift hielden zich bezig met de vraag hoe het kan dat sommige mensen zo goed zijn in het volhouden van hun dieet, terwijl anderen falen en juist teveel gaan eten. De bevindingen zijn consistent met het idee dat cognitief motivationele processen betrokken zijn bij verstoord eetgedrag. Zowel onsuccesvolle lijners als AN patiënten werden sneller afgeleid door voedselplaatjes. In een positieve stemming én wanneer voedsel taakirrelevant was, toonden AN patiënten een naderneiging voor voedselstimuli. AN patiënten vertoonden anderzijds een verminderde automatische neiging om voedsel te naderen zowel wanneer voedsel taakrelevant als -irrelevant was. Specifiek een verminderde automatische naderneiging wanneer voedsel taakrelevant was en dus niet genegeerd kon worden om de taak goed uit te voeren, lijkt een cruciaal kenmerk van AN. Deze verminderde neiging, kan samen met de bewuste intentie, helpen verklaren waarom AN patiënten het zo goed lukt om hun dieet vol te houden en dat ze ook in momenten van verminderde zelfcontrole niet voor de bijl gaan. Hoewel de automatische naderneiging tot voedsel in niet-maaltijdsituaties 1 jaar na de start van de behandeling was toegenomen, hing dit niet direct samen met verminderde eetstoornissymptomen en kon naderneiging op baseline geen behandelresultaat na een jaar voorspellen. Dit ondersteunt dus niet het idee dat een verminderde automatische naderneiging voor voedsel verbetering in de weg staat en dat toename van automatische naderneiging cruciaal is voor het herstel, in ieder geval voor wat betreft het naderen van voedsel in niet- eetrelevante situaties.

Wat kunnen we nu concluderen als we kijken naar de beginvraag, hoe het kan dat het de meeste mensen het niet lukt om hun dieet vol te houden, terwijl AN patiënten zich juist op een zelfdestructieve manier vasthouden aan hun dieet? Samengevat lijken zowel temporele aandachtsbias en automatische naderneiging betrokken bij verstoord eten. Omdat verhoogde afleidbaarheid voor voedselplaatjes echter bij zowel succesvolle als onsuccesvolle lijners voorkomt, kan het niet de verschillen in eetgedrag verklaren. Het kan echter wel zijn dat het verschillende vormen van dysfunctioneel eetgedrag in stand houdt. Verder lijkt een zwakke automatische naderneiging voor voedsel AN patiënten te helpen hun lijngedrag vol te houden, terwijl een sterke naderneiging voor voedsel buiten eetsituaties om, er juist voor lijkt te zorgen dat lijners verleid worden tot het eten van producten die ze eigenlijk willen vermijden.

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Curriculum vitae

Dankwoord

Publicaties

CURRICULUM VITAE

Renate Neimeijer werd op 25 maart 1986 geboren in Zwolle. Ze groeide op in Heino en verhuisde op haar 18e naar Groningen voor de studie psychologie. Na haar studie werkte ze kortdurend als neuropsycholoog in een verpleeghuis. In 2010 startte zij met haar promotietraject bij de Rijksuniversiteit Groningen. Dit samenwerkingsproject tussen Accare, RUG en PPO bood de mogelijkheid om klinisch werken met wetenschappelijk onderzoek te combineren. In 2012 startte ze met de opleiding tot gezondheidszorgpsycholoog bij Accare kinder- en jeugdpsychiatrie. Dit rondde ze in 2014 af. In januari 2018 is ze gestart met de vierjarige post master opleiding tot klinisch psycholoog kind & jeugd. Renate werkt als behandelaar bij Accare en is in haar werk gespecialiseerd in diagnostiek en behandeling van kinderen en jongeren met voedings- en eetstoornissen. Daarnaast werkt zij als onderzoeker / docent bij de afdeling klinische psychologie en experimentele psychopathologie aan de Rijksuniversiteit Groningen. Renate woont in Groningen met haar man Niels en zoon Olivier.

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